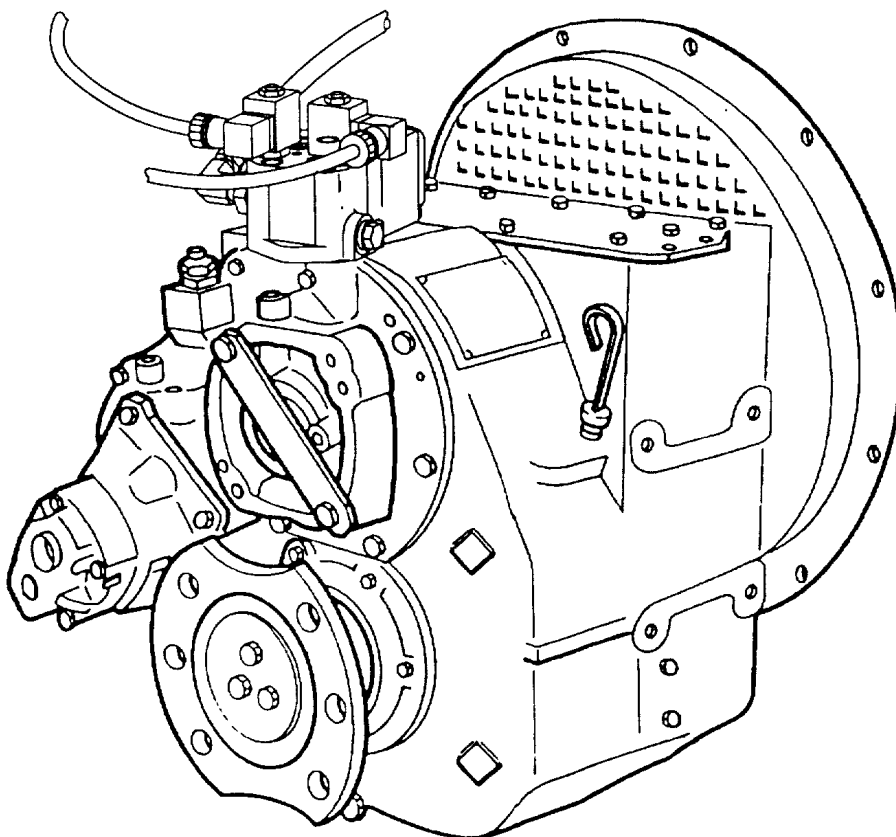


TECHNICAL MANUAL

**UNIT, DIRECT SUPPORT AND GENERAL SUPPORT
MAINTENANCE MANUAL**

**MARINE TRANSMISSION
MODEL DD-5111V**



INTRODUCTION 1-1

**MAINTENANCE
INSTRUCTIONS 2-1**

**MAINTENANCE
ALLOCATION
CHART (MAC) A-1**

**COMPONENT OF
END ITEM/BASIC
ISSUE ITEMS LIST
(COE/BIIL) B-1**

**EXPENDABLE/DURABLE
SUPPLIES AND
MATERIALS LIST C-1**

**MANUFACTURED
ITEMS LIST (MIL) D-1**

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HEADQUARTERS, DEPARTMENT OF THE ARMY

29 AUGUST 1997

TECHNICAL MANUAL
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HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON D.C., 29 AUGUST 1997

Unit, Direct Support, and General Support Maintenance Manual

MARINE TRANSMISSION MODEL DD-5111V

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes, or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual directly to: Commander, US Army Tank-Automotive and Armaments Command, ATTN: AMSTA-AC-NML, Rock Island, IL 61299-7630. A reply will be furnished directly to you.

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TABLE OF CONTENTS

CHAPTER 1	INTRODUCTION	1-1
Section I	General Information	1-1
Section II	Equipment Description	1-1
CHAPTER 2	MAINTENANCE INSTRUCTIONS	2-1
Section A	Introduction	A-1
Section B	Description	B-1
Section C	Principles of Operation	C-1
Section D	Hydraulic System	D-1
Section E	Preventive Maintenance	E-1
Section F	Troubleshooting	F-1
Section G	Oil Seal Replacement	G-1
Section H	Removal	H-1
Section I	Disassembly	I-1
Section J	Cleaning and Inspection	J-1
Section K	Assembly	K-1
Section L	Installation	L-1
Section M	Alignment	M-1
Section N	Torque Values	N-1
Section O	Assembly Drawings	O-1
APPENDIX A	MAINTENANCE ALLOCATION CHART (MAC)	A-1
APPENDIX B	COMPONENTS OF END ITEM/ BASIC ISSUE ITEMS LIST (COEI/BIIL)	B-1
APPENDIX C	EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST	C-1
APPENDIX D	MANUFACTURED ITEMS LIST	D-1
	INDEX	INDEX-1

CHAPTER 1

INTRODUCTION

Section I.	GENERAL INFORMATION	1-1
Section II.	EQUIPMENT DESCRIPTION AND DATA	1-1

OVERVIEW

This chapter contains general information pertaining to the Marine Transmission.

Section I. GENERAL INFORMATION

1-1 SCOPE. This manual contains instructions for Unit, Direct Support, and General Support Maintenance levels for the Marine Transmission, model number DD-5111V.

1-2 SAFETY PRECAUTIONS. Safety notices and instructions are found within the body of the maintenance instructions.

1-3 MAINTENANCE FORMS AND RECORDS. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750 as contained in the Maintenance Management Update.

1-4 DESTRUCTION OF ARMY MATERIAL TO PREVENT ENEMY USE. Procedures for destruction of Army material to prevent enemy use are contained in TM 750-244-6.

1-5 REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIRs). If your MCF system needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell what you don't like about your equipment, design or performance. Put it on a SF 368 (Product Quality Deficiency Report) Mail it to us at: Commander, U.S. Army ATCOM, ATTN: AMSAT-I-WTT, 4300 Goodfellow Blvd., St. Louis, MO, 63120-1798.

1-6 WARRANTY INFORMATION. The Modular Causeway Ferry (MCF) is warranted for eight months upon delivery. The warranty starts on the date found in block 23, DA Form 2408-9 in the logbook. Report all defects in material and workmanship to your supervisor, who will take appropriate action.

Section II. EQUIPMENT DESCRIPTION AND DATA

1-9 EQUIPMENT CHARACTERISTICS, CAPABILITIES AND FEATURES. Detailed descriptions, engineering data, and tabulated data are found in data covering the marine transmission are described in Sections A and B. Principles of operation are found in Section C. Functions of the hydraulic system are found in Section D.

1-10 SPARE/REPAIR PARTS. The spare and repair parts for the transfer case are found in TM 55-1945-20524P, Unit Level, Direct Support and General Support Repair Parts and Special Tools List (RPSTL).

CHAPTER 2

MAINTENANCE INSTRUCTIONS

Section A	INTRODUCTION	A-1
Section B	DESCRIPTION	B-1
Section C	PRINCIPLES OF OPERATION.....	C-1
Section D	HYDRAULIC SYSTEM.....	D-1
Section E	PREVENTIVE MAINTENANCE	E-1
Section F	TROUBLESHOOTING.....	F-1
Section G	OIL SEAL REPLACEMENT	G-1
Section H	REMOVAL.....	H-1
Section I	DISASSEMBLY	I-1
Section J	CLEANING AND INSPECTION	J-1
Section K	ASSEMBLY	K-1
Section L	INSTALLATION	L-1
Section M	ALIGNMENT.....	M-1
Section N	TORQUE VALUES	N-1
Section O	ASSEMBLY DRAWINGS.....	O-1



CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of the transmission. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

The service procedures recommended by Detroit Diesel Corporation and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by Detroit Diesel Corporation, must first determine that neither his safety nor the safe operation of the transmission will be jeopardized by the replacement part, service procedure or tool selected.

It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during service or repair or the possibility that improper service or repair may damage the transmission or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is impossible for Detroit Diesel Corporation to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

MARINE TRANSMISSION

DD-5111V
Marine Transmission**SECTION INDEX****INTRODUCTION****A****DESCRIPTION****B****PRINCIPLES OF OPERATION****C****HYDRAULIC SYSTEM****D****PREVENTIVE MAINTENANCE****E****TROUBLE SHOOTING****F****OIL SEAL REPLACEMENT****G****REMOVAL****H****DISASSEMBLY****I****CLEANING AND INSPECTION****J****ASSEMBLY****K****INSTALLATION****L****ALIGNMENT****M****TORQUE VALUES****N****ASSEMBLY DRAWINGS****O**

GENERAL INFORMATION

This maintenance manual is designed to provide instructions for the operation, removal, disassembly, assembly and installation of the DD-5111V Marine Transmissions. Engineering details and the performance characteristics of marine transmissions can be obtained from the Marine Application Department of Detroit Diesel Corporation.

Tool drawings can be ordered from your authorized Detroit Diesel Distributor/Dealer.

Assembly drawings with exploded view illustrations are located in Section "O" to facilitate ordering replacement parts. Additionally, this manual includes a troubleshooting chart to help determine, and solve functional difficulties that may occur; and operating specifications, aids to installation and other pertinent data to comprehensively cover all aspects of the operation/ maintenance of this equipment.

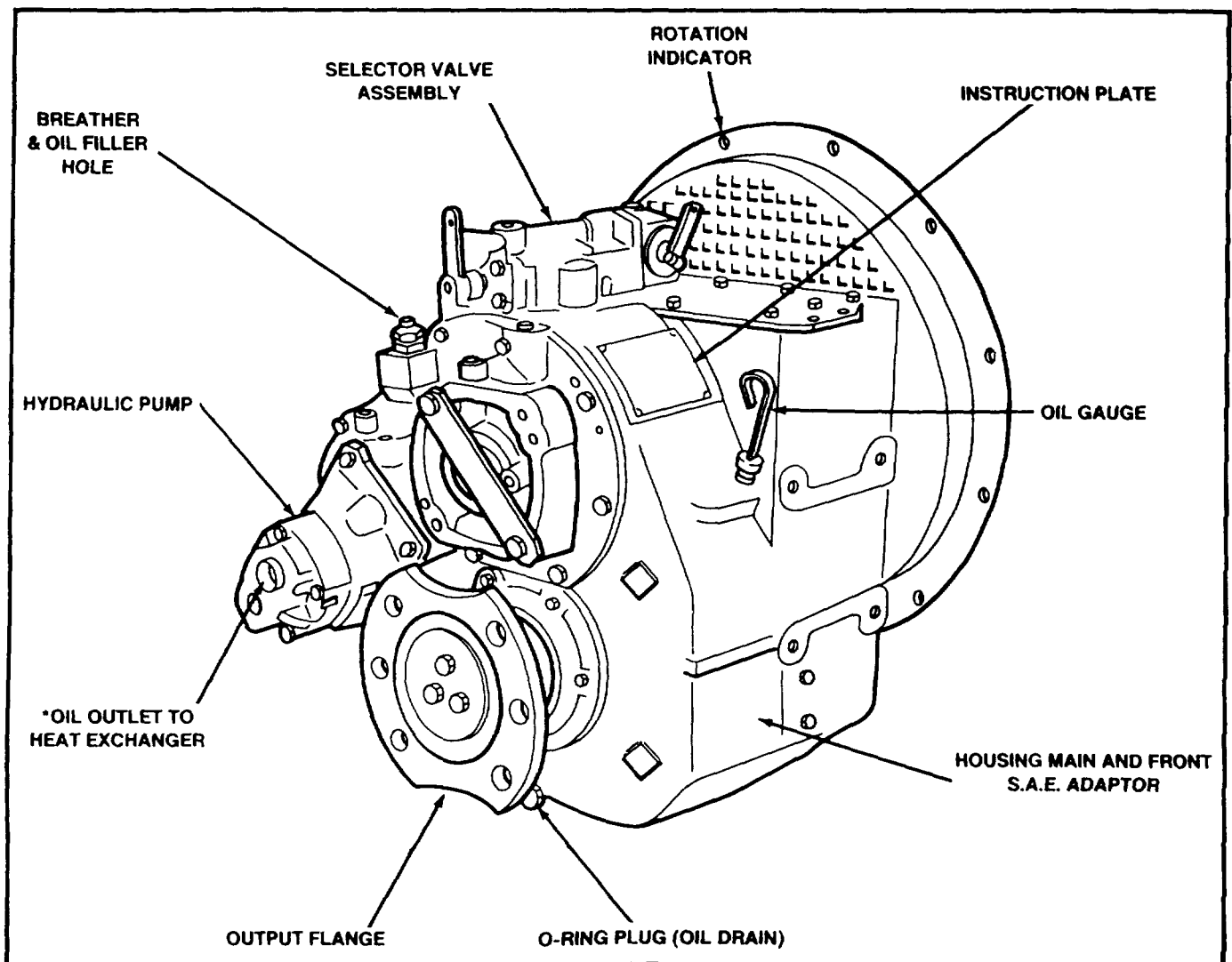


FIGURE A-1: Model DD-5111V Marine Transmission-Rear View

DISTRIBUTION

It is recommended that this maintenance manual be made available to, and read by, all personnel responsible for the operation or maintenance of the marine transmission. A thorough understanding of the material in this manual will result in increased life and satisfactory service from the marine transmission.

ORDERING PARTS

Source

Repair Parts, Service Parts Kits can be obtained from your authorized Detroit Diesel Corporation Distributor or Dealer.

Method

When ordering a spare or replacement part, always provide the transmission Model Number, BOM No., Serial No., and Ratio. These numbers are listed on the Instruction Plate which is located on the transmission main housing. (See Figure A-1A). In addition to giving the description and quantity of the item(s) required, it is helpful to give the item number for each item you are ordering as shown in Section "O" of this manual titled "Assembly Drawings". You will find that many internal components are not serviced individually, but may be available in kit form, however, external components such as oil plugs, hydraulic pumps, control valves, oil

dipsticks, etc. are available separately. In the event a particular item is required but is not listed, contact your Detroit Diesel Corporation Distributor for availability information.

DETROIT DIESEL CORPORATION

MARINE TRANSMISSION

MODEL NO. _____

BOM NO. _____

SERIAL NO. _____

OIL CAPACITY _____ GAL

MINIMUM OIL PRESSURE CRUISING _____ PSI

CUSTOMER NO. _____

RATIO _____

(BILL OF MATERIAL NO. MUST BE GIVEN WHEN ORDERING PARTS)

LUBRICATION
EVERY 10 SERVICE HOURS OR DAILY, CHECK OIL LEVEL WITH ENGINE RUNNING AND MARINE TRANSMISSION IN NEUTRAL
EVERY 1000 SERVICE HOURS OR 6 MONTHS, WHICHEVER COMES FIRST
DRAIN AND REFILL HOUSING WITH CLEAN OIL, CLEAN SUCTION SCREEN

IMPORTANT: WARRANTY IS VOID UNLESS TRANSMISSION IS LUBRICATED AND MAINTAINED AS SPECIFIED IN THE SERVICE MANUAL AVAILABLE ON REQUEST REFER TO "MARINE TRANSMISSION LUBRICANT" PLATE SHIPPED WITH UNIT

MANUFACTURED FOR DETROIT DIESEL CORP.
 BY TWIN DISC INCORPORATED

MADE IN U.S.A.

P6787

FIGURE A-1A: Instruction Plate

PARTS SHIPMENT

Method

Shipments will be made in accordance with normal distributor shipment methods, unless otherwise specified and agreed upon at time of purchase.

Destination

Furnish the complete shipping destination and postal address.

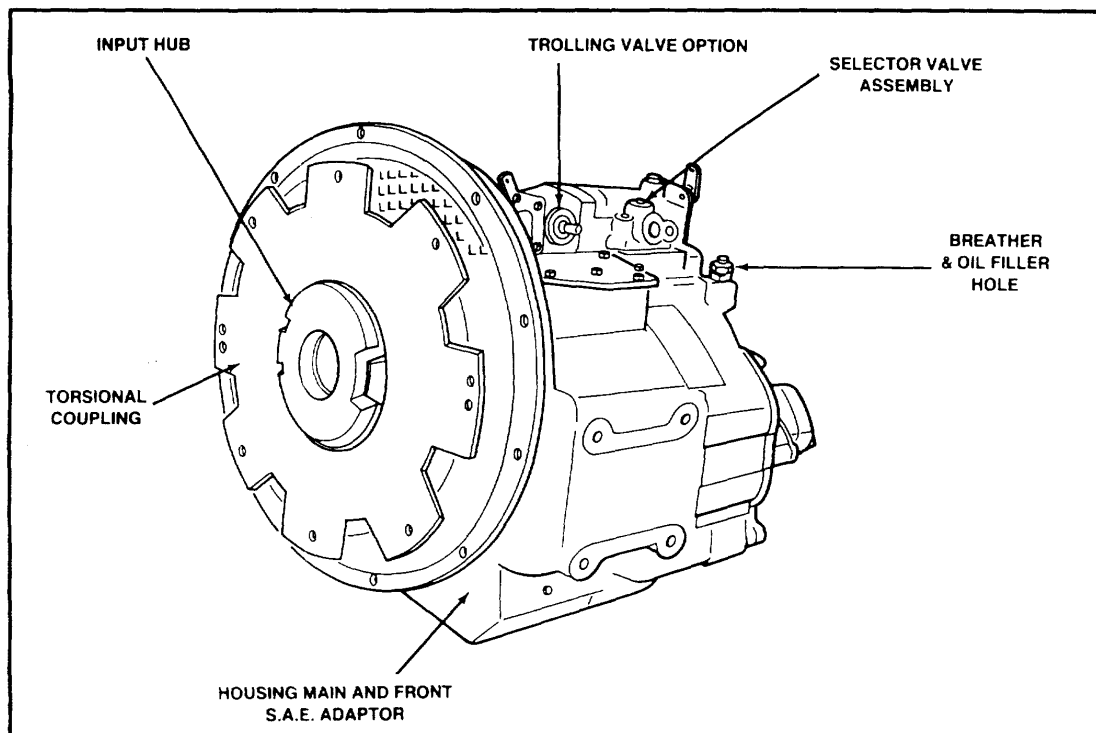


FIGURE A-2: Model DD-511 V Marine Transmission - Front View.

MARINE TRANSMISSION

General

The DDC Model DD-5111V Marine Transmission can be modified for use with a left-hand rotation engine (when viewed from the front of the engine). See Section C for conversion instructions.

**ALWAYS MAKE SURE THAT ENGINE
AND TRANSMISSION ROTATION
AGREE.**

The marine transmission consists of four major subassemblies: the forward clutch group of parts, the reverse clutch group of parts, the input group of parts, and the output group of parts. The selector valve assembly is externally-mounted on the top of the unit over the forward clutch location. The selector valve assembly is the control device that hydraulically engages the desired clutch. An oil pump assembly is externally mounted at the rear of the unit behind the reverse clutch location. The oil pump assembly supplies oil under pressure to the selector valve assembly through the pump mount for clutch engagement, clutch cooling, and bearing and gear lubrication. The oil is strained and filtered (when filter used) before entering the marine transmission hydraulic system. The DD-5111V Marine Transmissions are flange-type units that are bolted directly to the engine flywheel housing. The input group furnished with the transmission is installed on the engine flywheel. This method of drive is used because of the comparative ease of removal and installation; however, care must be exercised during installation to ensure that proper alignment between the marine transmission and the engine is attained.

The designation "Forward and Reverse" clutch assembly does not necessarily mean that the boat propulsion direction agrees. In marine transmission engineering terms, the "Forward" clutch assembly, when engaged, means the drive from input to output is through the least number of gears. With a right-hand engine, the forward clutch will cause the output shaft to turn in the anti-engine direction. The "Reverse" clutch, when engaged, directs the drive through the greatest number of gears from input to output. With a right-hand engine, the reverse clutch causes the output shaft to turn in the engine direction. With a left-hand engine, the "Forward"

clutch will cause the output shaft to turn in the anti-engine direction. Likewise, the "Reverse" clutch will cause the output shaft to turn in engine direction. In the model DD-5111V for forward clutch drive train includes three gears; the reverse clutch drive train includes four gears.

Reduction Ratios

The following reduction ratios are available with the model DD-5111V Marine Transmissions described in this maintenance manual: 1.12:1, 1.50:1, 1.74:1, 2.04:1, 2.54:1, 3.10:1, 3.28:1, 3.92:1, 4.44:1, 4.95:1.

Optional Equipment offered by DDC

The accessories described below are available for the DD-5111V Marine Transmissions.

Trolling Valve

The trolling valve provides the ability to obtain lower propeller speeds than would be possible at engine idle speed with clutch fully engaged.

Companion Flange

Power Take-Off

Three optional PTO's are available for the DD-5111V.

- Live SAE C pump mount.
- Hydraulic clutch SAE C pump mount
- Hydraulic clutch shaft drive

INPUT GROUP OF PARTS

The input group transfers power from the engine flywheel to the marine transmission. The input group may consist of a Torsional Coupling or a rubber block drive. When a Torsional Coupling is used, it substitutes for the driving ring, drive spider, and rubber blocks.

Torsional Coupling

The Torsional Coupling is composed of the flywheel drive plate, rubber element, driven plate, and input shaft hub.

Driving Ring

The driving ring is a high-quality aluminum casting that is bolted to the engine flywheel. The ring has internal gear teeth that mesh with the rubber blocks installed on the drive spider.

Drive Spider

The drive spider, with rubber blocks installed, is the connecting member between the driving ring on the engine flywheel and the marine transmission. (External lugs are machined on the drive spider for rubber block installation). The drive spider is mounted on the splined input gear shaft.

Rubber Blocks

The rubber blocks, molded in an involute tooth shape, are installed on the external lugs of the drive spider. Misalignment caused by hull distortion is absorbed by the cushioning effect of the rubber blocks; however, extreme care must be observed during marine transmission installation to achieve the dial indicator tolerances specified in the section on installation.

Input Gear Shaft

The protruding input end of the input gear shaft is splined for the installation of the drive spider or Torsional Coupling. Tapered roller bearings are mounted on the shaft on both sides of the input gear. One bearing cup is installed in the bearing support, and the other bearing cup is installed in a web of the main housing. On the DD-5111V, the input gear shaft also functions as the forward clutch shaft.

Input Gear

The input gear is made in one piece with the input shaft and located between tapered roller bearings. The input gear turns in engine direction, and is in constant mesh with the forward clutch housing gear.

FORWARD AND REVERSE CLUTCH GROUP OF PARTS

General

The forward clutch group of parts and the reverse clutch group of parts are identical in construction and parts, except for the width of the clutch housing gears. Therefore, the following description will apply to both the forward and reverse clutch groups of parts.

Clutch Shaft

The clutch shaft is made of steel, and contains two horizontally-drilled passages that are intersected by cross-drilled holes. One passage supplies oil pressure for clutch engagement, and the other passage supplies oil pressure for clutch cooling and lubrication of moving parts. A solid ball plug is installed at the rear end of the clutch engagement passage in the clutch shaft to contain the oil. An orifice is drilled at the front end of the cooling and lubrication passage in the clutch shaft to permit a metered flow of oil to return to lubricate the front tapered bearings. A slot milled in the rear end of the clutch roller bearing installed on each end of the clutch shaft (and in the main housing) supports the clutch shaft, and therefore the clutch pack, in the marine transmission. Ring-shaped grooves are machined in the clutch shaft for a snap ring and two piston rings. Two piston rings are installed in the grooves at the rear end of the clutch shaft to direct oil to the proper passage. An external snap ring, used to retain the return spring, is installed in the groove of the clutch shaft at approximately the mid-point of the shaft.

Clutch Pack

The clutch pack is contained within the clutch housing gear, and consists of a clutch piston, a pin, the clutch piston spring, sintered metal clutch plates, steel clutch plates, the backplate, the clutch hub pinion assembly, and needle thrust bearings. The clutch housing gear is bored internally to contain the clutch piston. A pin prevents rotation between the clutch piston and the clutch housing gear. The O-ring installed in the clutch piston seals the inside diameter of the clutch piston. Likewise, a piston ring is installed on the outer periphery of the clutch piston. The clutch piston spring is held in location by a spring retainer and snap ring. The pinion assembly has external splines which engage the steel clutch plates. The pinion assembly is in constant mesh with the output gears. All gears are in constant mesh, power flow depends on the engagement of the forward or reverse clutch pack.

Clutch Housing Gear

A clutch housing gear is fixed to each clutch shaft. The clutch housing gear is mounted between the pinion and rear shaft bearing. Since the input gear shaft also functions as the forward clutch shaft on the DD-5111V, the forward clutch housing gear rotates at the same speed as the engine. The forward clutch housing gear is in constant mesh with the reverse clutch housing gear. The internal teeth of the clutch housing gear engage the external teeth of the sintered metal clutch plates and

back plate. Cross drilled holes in the clutch housing gear permit the cooling and lubricating oil to return to the sump. A dump valve is provided to relieve oil pressure when the clutch is not engaged.

MAIN HOUSING GROUP OF PARTS

Main Housing Assembly

The main housing is a high quality casting that has integral mounting pads for the support of the marine transmission on the engine bed rails. The main housing assembly contains the gears, shafting, and forward bearings for all the drive components. The oil sump is also part of the main housing. The flywheel housing adapter is cast as an integral component of the assembly in the DD-5111V series. The selector valve assembly and inspection cover are located on the top of the main housing assembly.

Manifold Assembly

The manifold assembly provides oil passages, a mounting pad for the oil pump, and p.t.o. mounting pad. Bolts secure the manifold assembly and bearing carrier to the front housing.

Bearing Carrier

The bearing carrier is mounted between the main housing assembly. The bearing carrier locates the rear bearing cones of all power transmitting shafts. The bearing carrier is aligned with the front housing via two dowels.

OIL PUMP ASSEMBLY

Oil Pump Assembly

The oil pump assembly is a positive-displacement, gear pump that is tang driven by the reverse clutch shaft. The oil pump assembly is secured to the manifold assembly by a gasket and four hex-head cap screws. The oil pump assembly is driven at engine speed and has a rated capacity of 12 gpm at 3000 rpm.

Suction Tube

The suction tube connects the filter screen and the inlet port of the oil pump assembly.

SELECTOR VALVE ASSEMBLY

General

The selector valve assembly is mounted on the top of the main housing of the marine transmission with four hexhead capscrews. The selector valve assembly consists of the selector valve group of parts and the main regulator valve group of parts assembled in a common valve bore in the main regulator valve body. The selector valve hydraulically functions by the mechanical movement of the shaft lever, and the main regulator valve controls main and lube oil pressure in the hydraulic system.

Selector Valve Group of Parts

The selector valve group of parts consists of the valve body, cover, cover gasket, shift lever, detent assembly plate and valve spool. The rotary-type selector valve, actuated by lever movement from the operator to one of three positions: "neutral", "forward" or "reverse" directs the oil flow to the selected clutch, automatically draining the opposite clutch at atmospheric pressure, through integral passages in the valve body bore. From the detented neutral position, the lever is moved 40 degrees against a positive stop to either forward or reverse clutch positions. The detent ball and plate assembly holds the valve in the selected position, aligning the desired circuit passages. An "O" ring seals the valve spool in the valve body from external leakage along the spool.

44-133 N (10-30 lbs.) at the 56.0 (2.2) radius location of the 6.35 (1/4) dia. hole is required to overcome detent effort. The detent feature is provided in the full forward, full reverse and neutral lever positions. The detent spring and pin may be omitted when remote control systems provide forward, neutral and reverse detents that correspond exactly with valve detent positions. Force at the lever hole to operate the valve then reduces to 13-31 N (3-7 lbs.). The remote control valve actuator must provide ± 35.8 (1.41) linear travel from neutral at the 6.35 (1/4) dia. hole location. Rotational stops at the stated valve travel units have a maximum capacity of 445 N (100 lbs.) at the 6.35 (1/4) dia. hole location. Valve actuators with force capability exceeding this limit must have separate stopping devices so capacity of the valve rotational stops is not exceeded. Exceeding the capacity of the valve rotational stops can cause loss of control.

Main Regulator Valve Group of Parts

The main regulator valve group of parts consists of the piston, and a pair of springs. Shims, one or two usually, are placed behind the springs to increase the oil pressure rating to the desired range.

The piston fits in the drilled end of the selector valve spool. A large flange on the bottom of the piston operates against the springs when oil pressure is exerted on the top of the piston. As the piston moves towards its regulating point, it uncovers a port to the lubrication circuit. The overage oil from the regulating piston supplies the necessary lube pressure for the unit.

HEAT EXCHANGER

Adequate cooling is provided by the DDC factory package. Contact DDC for cooling requirement if additional details are needed.

OUTPUT GROUP OF PARTS

Output Shaft

The larger diameter central area of the output shaft is tapered for the installation of the output gear. The output shaft tapered roller bearings are installed on the shaft on both sides of the output gear. One bearing cup is installed in the bearing bore of an integral web of the main housing, and the other bearing cup is installed in a bearing bore in the bearing carrier. A hollowed dished oil retainer shield is fitted in the bottom of the front

bearing bore to supply lubricating oil to both input and output bearings.

Output Gear

The output gear is installed on the tapered area of the output shaft between the output shaft tapered roller bearings. The output gear is in constant mesh with the forward clutch hub pinion assembly and the reverse clutch hub pinion assembly.

Output Flange

The output flange is spline-connected on the output shaft, and secured to the shaft by the lathe-cut rubber seal ring, the retainer washer and the hex-head screws. The seal ring prevents oil leakage past the splined areas of the output shaft and the output flange. The output flange also provides for the installation of a sixbolt companion flange.

GENERAL INFORMATION CHART

The following table provides general information relative to marine transmission operation. These specifications must be observed to obtain proper operation of the marine transmission.

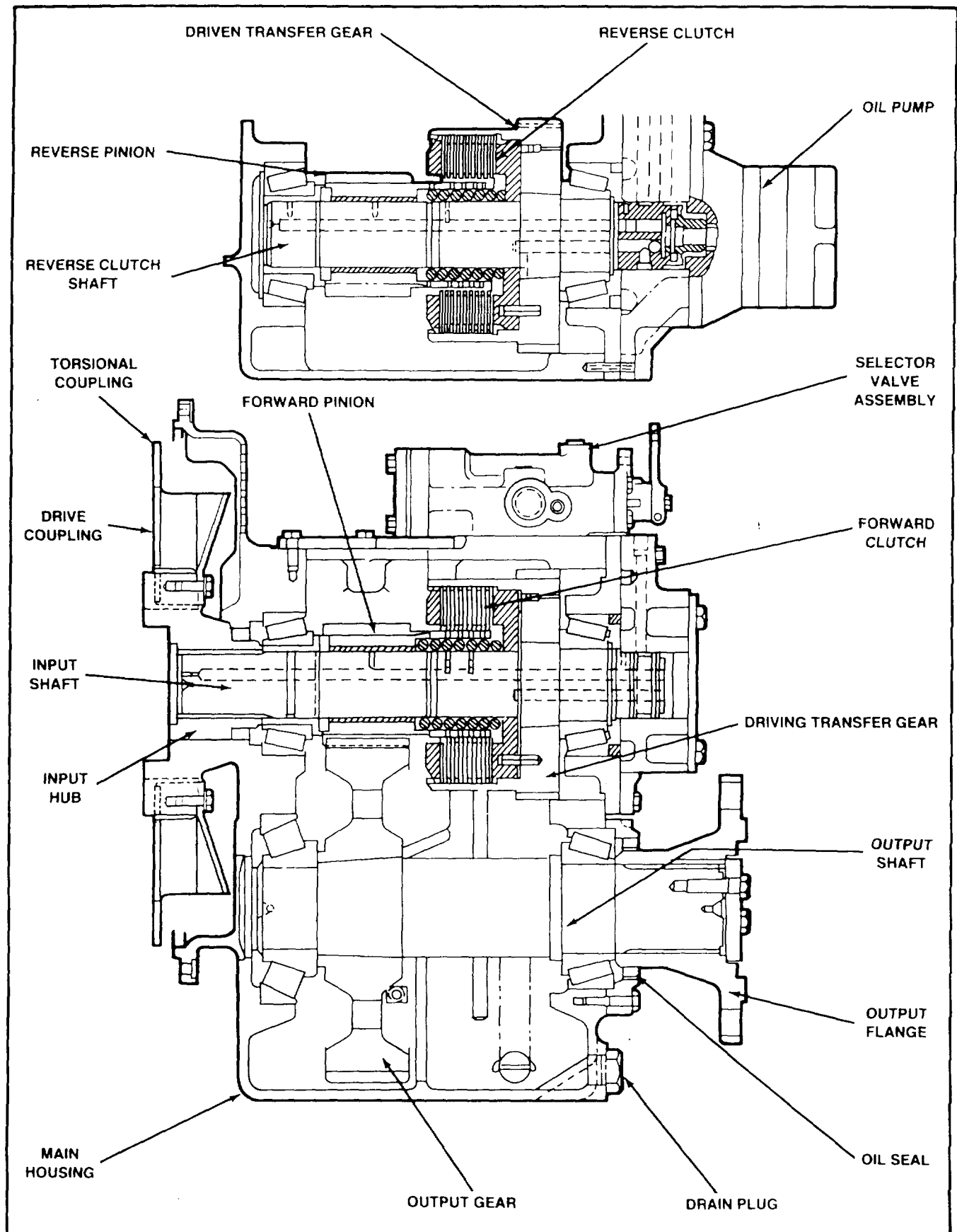


FIGURE B-1: Model DD-5111V - Marine Transmission - Cross Section.

TABLE 1. GENERAL INFORMATION

OIL PRESSURE

For 230 psi spring Normal 220 - 240 psi at 1800 rpm and 180° F. (Minimum 225 psi at cruising speed).
Cooling and Lube: 20 psi Minimum at 1800 rpm and 180°F.

OIL CAPACITY

Approx. 2.8 U.S. gallons (Ratios 1.12:1 through 3.10:1) / Approx. 6.6 U.S. gallons (Ratios 3.28 through 4.95:1) or fill to "Full" mark on gauge, check with engine idling, transmission in neutral and oil at recommended operating temperature.

OIL SERVICE CLASS

Use SAE-API service class CD engine oil which is certified by the oil company to pass TO-2 or C-3 Test Specification.
Also approved is SAE-API service class CC engine oil, MIL-L-2104B.

OIL VISCOSITY

Sump Temperature, also Oil
Temperature into Heat Exchanger

Recommended Oil Viscosity

During
Start-up

Steady Operating
Conditions

Below 150° F.

This operating condition is not approved.

32° F. Min.

150° - 185° F.

SAE viscosity number 40 engine oil. 1.12:1 - 2.54:1

32° F. Min.

150° - 185° F.

SAE viscosity number 30 engine oil. 3.10:1 - 4.95:1

32° F. Min.

175° - 210° F.

SAE viscosity number 40 engine oil. 3.10:1 - 4.95:1

Above 210° F.

This operating condition is not approved.

OIL AND FILTER CHANGE INTERVAL

First element filter change should take place after 10 hours and thereafter every other engine oil change for both filter element and oil.

FILTER SCREEN

Remove and clean after first 10 hours and thereafter every time the oil is changed.

OIL PUMP CAPACITY

12 gpm at 3000 rpm at 250 psi.

MAXIMUM SPEED

3000 rpm.

SHIFTING LIMITS

Pleasure Craft Applications:

"Neutral" to "Forward" or "Neutral" to "Reverse": 1300 rpm.

"Forward-Neutral-Reverse" or "Reverse-Neutral-Forward": 1000 rpm

Intermediate and Continuous Applications:

"Neutral" to "Forward" or "Neutral" to "Reverse": 1800 rpm

"Forward-Neutral-Reverse" or "Reverse-Neutral-Forward": 1300 rpm.

DRY WEIGHT

DD5111V - Ratios 1.12:1 - 3.10:1 - Approximately 555 lbs.

DD5111V - Ratios 3.28:1 - 4.95:1 - Approximately 771 lbs.

GENERAL

This marine transmission has forward, neutral and reverse positions obtained by means of the control valve. When these positions are selected, the control valve directs high pressure oil through internal passages to operate the clutches.

DESCRIPTION

The models DD-5111V Marine Transmission are marine reverse and reduction transmissions available in nine ratios: 1.12:1, 1.50:1, 1.74:1, 2.04:1, 2.54:1, 3.10:1, 3.28:1, 3.92:1, 4.44:1, 4.95:1. Within their rated capacities, all ratios may be operated continuously in the forward and reverse directions with Right Hand Rotation diesel engines.

The DD-51 11 V Marine Transmission can be modified to work with left hand engines, see details later in this section. With left hand engines, full rated power is only available thru reverse clutch for ahead.

ALWAYS MAKE SURE THAT ENGINE AND TRANSMISSION ROTATION AGREE.

The marine transmission is completely hydraulic in all phases—all bearings are oil lubricated, both clutches are engaged by high pressure oil, and both clutches are oil lubricated and oil cooled.

DIRECTION OF DRIVE

The input group and forward clutch assembly are fixed to the input shaft, and spin at engine speed. The reverse clutch assembly is in constant mesh with the forward clutch assembly, so it spins in the anti-engine rotation at engine speed. When the forward clutch is engaged, the output shaft spins in the anti-engine direction. If the reverse clutch is engaged, the output shaft spins in engine direction.

POWER FLOW (Fig. C-1)

Neutral

When in neutral, the forward and reverse shafts, transfer gears, and steel clutch plates rotate at engine speed. Other parts including the output shaft do not turn.

Forward

In forward, the same parts are turning that were turning in neutral. When the forward position is selected, hydraulic pressure is applied to the forward clutch piston clamping the friction and steel clutch plates together. The forward pinion will then rotate at engine speed and direction, because the friction plates are spline-connected through the clutch driving transfer gear to the pinion. Since the forward pinion is in mesh with the output gear, the output gear and shaft will rotate in anti-engine direction. The reverse pinion will free-wheel (engine direction) when the unit is in forward.

The output shaft and output flange rotate at a speed that is reduced from the engine speed due to the ratio between the input gear and output gear.

Reverse

In reverse, the same parts are turning that were turning in neutral. When the reverse position is selected, hydraulic pressure is applied to the reverse clutch piston clamping the friction and steel plates together. The reverse pinion will then rotate at engine speed and anti-engine direction, because the friction clutch plates are spline-connected through the clutch driven transfer gear to the pinion. Since the reverse pinion is in mesh with the output gear, the output gear and shaft will rotate in engine direction. The forward pinion will free-wheel (anti-engine direction) when the unit is in reverse.

The output shaft and output flange rotate at a speed that is reduced from the engine speed due to the ratio between the input gear and output gear.

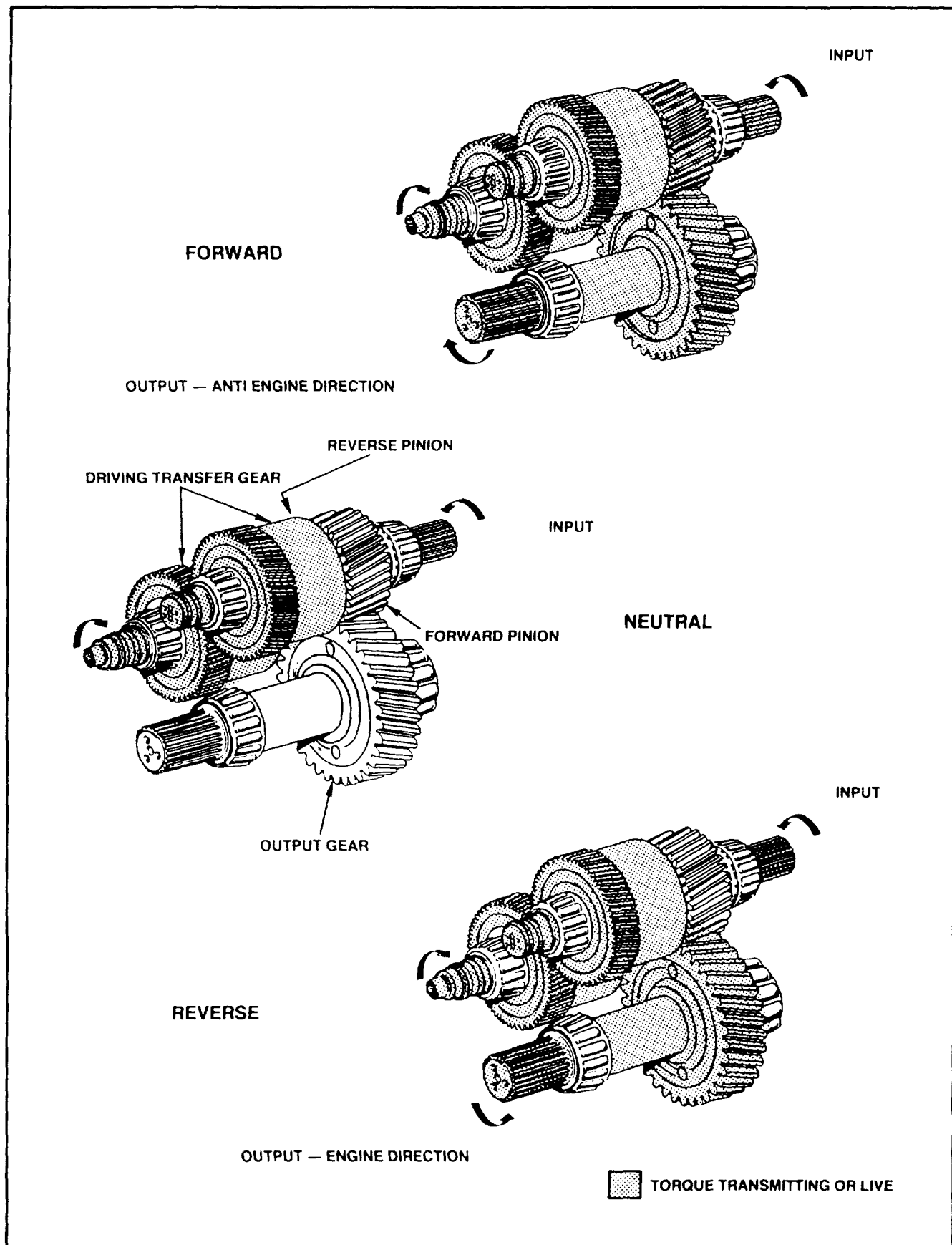


FIGURE C-1: Model DD-5111V Marine Transmission Power Flow - Forward - Neutral - Reverse

BACK DRIVING

The DD-5111V series marine transmissions can be back-driven (propeller windmilling with dead engine) under the following conditions provided that the vessel speed when back driving the marine transmission, does **not** exceed the **normal propulsion speed** of the vessel.

Examples:

- * Towing to deliver a boat.
- * Towing home a boat with engine trouble.
- * Sail boat auxiliary.
- * Multiple screw vessel with engine(s) shut down.

Selective methods required for Back Driving (any one will suffice).

1. Start the engine and operate the marine transmission in Neutral at normal fluid pressures for a minimum of five (5) minutes, doing this once every eight (8) hours. Maintain the back driven marine transmission's oil level at the full mark on the dipstick.

2. Lock the propeller shaft to prevent rotation.

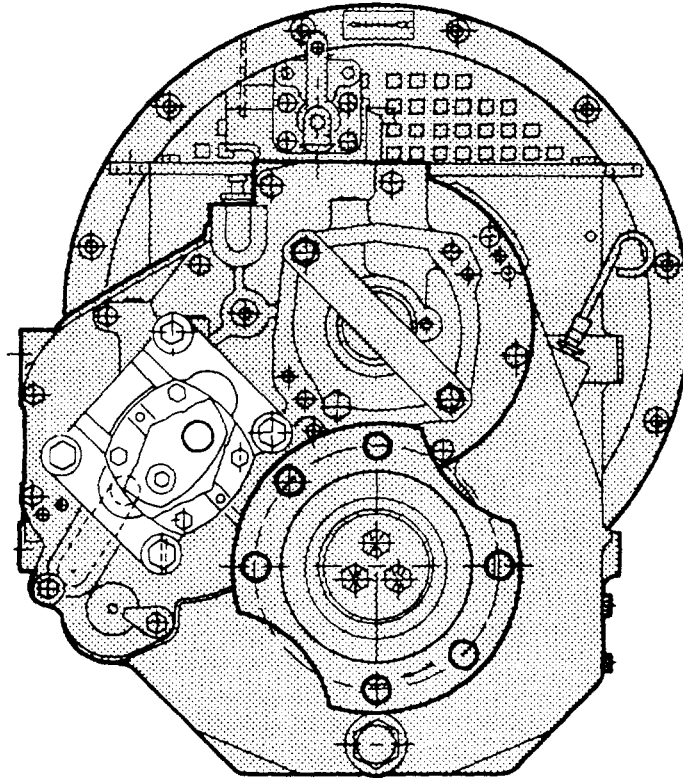
3. It is possible to add an electric auxiliary oil pump into the lube circuit. See the hydraulic system prints for more details on auxiliary pump specifications for the applicable transmission or contact Detroit Diesel.

4. In the case of an inoperable engine where pressure Tubing the transmission is not possible, plug the dipstick tube and fill the unit with oil; then drain the oil down to full oil level. Repeat this process every 8 hours.

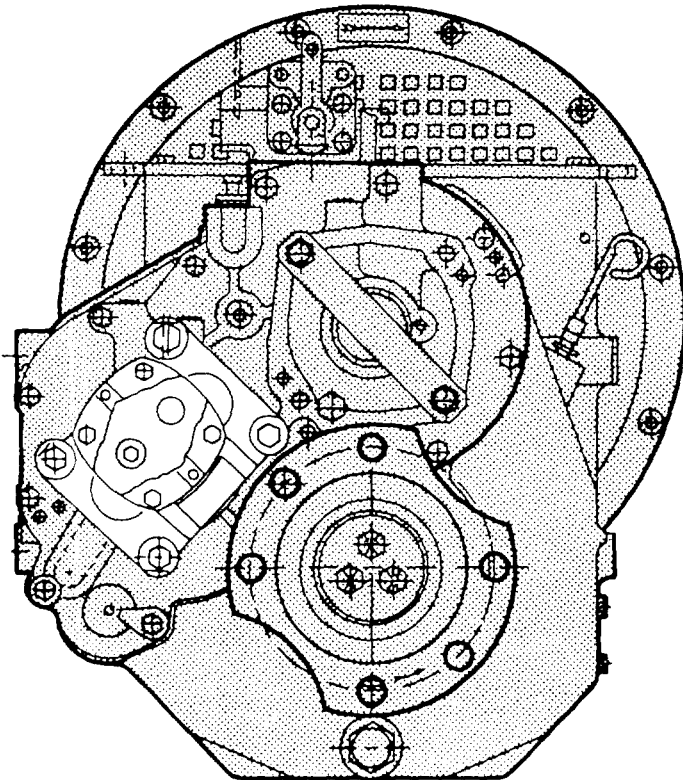
CONVERSION FOR USE WITH LEFT HAND ENGINE

When shipped from the factory, the marine gear is typically built for use with a right hand rotation engine. The DD-5111V series can be converted for use with a left hand rotation engine.

To adapt to the opposite engine rotation, remove the heat exchanger hose from the rear of the oil pump. Remove the pump, rotate it 180° and re-install the pump. Remove the plug from the rear of the pump, and install it where the heat exchanger hose was located. Install the heat exchanger hose where the plug was previously installed. Remove the rotation indicator plate and re-install it showing the opposite rotation.



R.H. ROTATION



L.H. ROTATION

FIGURE C-2: Illustrates how pump is rotated for opposite rotation.

HYDRAULIC SYSTEM D

GENERAL**Description**

The hydraulic system delivers oil pressure for clutch engagement, clutch cooling, and lubrication functions. The sump, which is located in the bottom of the housing, contains an adequate amount of oil for all functions of the system.

Oil is pumped through the system by the gear-type pump. The oil is taken from the sump through the strainer by the pump and discharged through the heat exchanger to the combination control and pressure regulating valve. The oil enters the pressure regulating area of the valve where main pressure is regulated by cascading excess oil into the lube circuit. Lube oil is distributed through fixed controlled orifices to lubricate bearings and cool the clutches.

In neutral, the inlet ports to the clutches are blocked, the clutches are disengaged, and the area behind the clutch pistons is open to sump. Oil is distributed through the lubrication system.

When the control valve is shifted to engage either clutch, the control valve directs main pressure to engage the selected clutch pack. Oil is also directed through a port in the control valve stem to a fixed orifice in the orifice plate causing a controlled flow of oil to unseat the rate-of-rise piston and move it to seat on a shoulder in the rate-of-rise piston bore compressing the pressure regulator springs. This progressively increases the clutch engaging pressure causing the clutches to engage at a controlled rate. Coverage oil becomes lube oil. The control valve allows only one clutch to be engaged at a time, and the oil from the disengaged clutch is dumped to sump. When a clutch is disengaged, any centrifugal pressure head existing behind the clutch apply piston is relieved to sump by the ball dump valve provided in the transfer gear. This allows the return springs to move the clutch piston to the disengaged position to prevent clutch drag.

The oil pump assembly pressurizes the oil for pressure requirements. The selector valve assembly functions as both a regulator and distributor for the hydraulic system.

The selector valve assembly directs the oil to engage either the forward or reverse clutch depending on the position of the selector valve. The selector valve assembly also directs oil to the lube system. Piston rings on the ends of the clutch shafts separate the lube and clutch pressure oil.

External Oil Circuit

Oil is drawn from the sump through the filter screen and suction tube to the oil pump assembly. From the oil pump assembly the oil is conveyed by a flexible hose to the remotely-located heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger through a flexible hose to the oil inlet port of the selector valve assembly. The ports in the selector valve and main housing convey oil to the reverse clutch shaft for clutch engagement and lubrication.

CONTROL VALVE ASSEMBLY

The control valve assembly contains passages and ports for the transmission and direction of pressurized oil within the hydraulic system. The pressure rate-of-rise piston within the control valve assembly provides a rapid, yet, smooth, pressure rise for the hydraulic system during clutch engagement.

Neutral

Oil is pressurized by the main regulator valve in the regulator valve body to approximately 85 psi. Overage oil from the valve chamber of the regulator valve enters the lube oil passages and a connecting tube conveys lube oil to the pump mount. The lubricating oil is supplied to both clutch shafts for cooling and lubricating functions in the marine transmission. Since neither clutch is engaged, the remainder of the oil in the chamber not required for cooling and lubrication is returned to sump. See Figures D-1 and D-2.

Forward Clutch Applied

Oil is pressurized by the main regulator valve in the regulator valve body to approximately 230 psi. Oil is routed by the selector valve spool in the valve body to an annular groove and cross drilled hole in the forward clutch shaft. An annular chamber formed in the rear of the clutch shaft is sealed on both sides by piston rings. The cross-drilled hole in the clutch shaft intersects a horizontally-drilled hole in the shaft that is terminated by a ball plug installed in the end of the shaft. A second cross-drilled hole, that also intersects the horizontally drilled hole, permits the oil to enter the chamber between the forward clutch housing gear and the clutch piston. The oil pressure moves the clutch piston against the clutch plates, and the forward clutch is engaged. Any oil that exists in the reverse clutch is returned to sump by the position of the selector valve the force exerted by the clutch piston spring and a ball dump valve. Overage oil in the regulator valve body chamber passes by the regulator valve and enters the lube oil tube for cooling and lubricating functions as described in Neutral. See Figures D-1 and D-3.

Reverse Clutch Applied

Oil is pressurized by the main regulator valve in the regulator valve body to approximately 230 psi. Oil is routed by the selector valve in the valve body to the annular groove and cross drilled hole in the reverse clutch shaft. An annular chamber formed in the rear of the clutch shaft is sealed on both sides by piston rings. The cross-drilled hole in the shaft that is terminated by a ball plug installed in the end of the shaft. A second cross-drilled hole that also intersects the horizontally drilled hole permits the oil pressure to enter the chamber between the reverse clutch housing gear and the clutch piston. The oil pressure moves the clutch piston against the clutch plates, and the reverse clutch is engaged. Any oil that exists in the forward clutch is returned to sump by the position of the selector valve the force exerted by the clutch piston spring and ball dump valve. Overage oil in the regulator valve body chamber passes by the regulator valve and enters the lube oil connecting tube for cooling and lubricating functions as described in Neutral. See Figures D-1 and D-4.

TROLLING VALVE OPTION

A trolling valve provides a means of varying the oil pressure on the clutch. Trolling is available through both the forward and reverse clutch. By varying the oil pressure, the clutch plates can slip relative to each other within a defined RPM range (30 - 70% of lock-up speed). Clutch input and output torque is transmitted via viscous friction in the oil film between the clutch plates. The oil not only acts as the media for torque transfer, but carries heat away from the clutch plates.

Under normal conditions, trolling results in negligible wear of the clutch plates. See Figure D-5.

Because heat is generated in the slipping clutch, each marine transmission equipped with a trolling valve has a recommended maximum input speed when in the trolling mode. The use of a trolling valve does not necessitate a larger heat exchanger. The heat exchanger is sized to absorb the heat load of the transmission running at rated conditions. The trolling valve speed and power limits prevent heat loads which exceed that of rated conditions. Exceeding these limits will cause premature wear and failure of the components.

Trolling valve input speed limit for DD-5111V is 1100 RPM or 40% of maximum governed engine speed - whichever is less.

The operator must select the trolling mode with the control valve lever in neutral and set the engine speed at or below the recommended maximum trolling rpm.

If transmission sump temperature drops below 135°F. during trolling operations, it may be necessary to install a thermostatic valve (part number 23508819) in the cooling system.

Trolling Valve - Non-trolling Mode

The trolling valve is in non-trolling mode when the cam/trolling lever is in the detent position. See Figure D-6. The trolling valve, with the cam/trolling lever in the non-trolling position, allows the valve to operate as a standard control valve.

Trolling Valve - Forward or Reverse

When the trolling valve is to be used for either forward or reverse the cam trolling lever is moved out of the detent position and into the trolling range. With the cam/trolling lever out of the detent position, the rate-of-rise piston position can be manually adjusted by the trolling lever to decrease the compression of the outer, middle, and inner springs against the high pressure regulator piston decreasing the clutch apply pressure. See Figure D-7.

With the cam/trolling lever out of detent, the trolling valve provides manual control by adjustment of trolling lever at low pressures required for trolling.

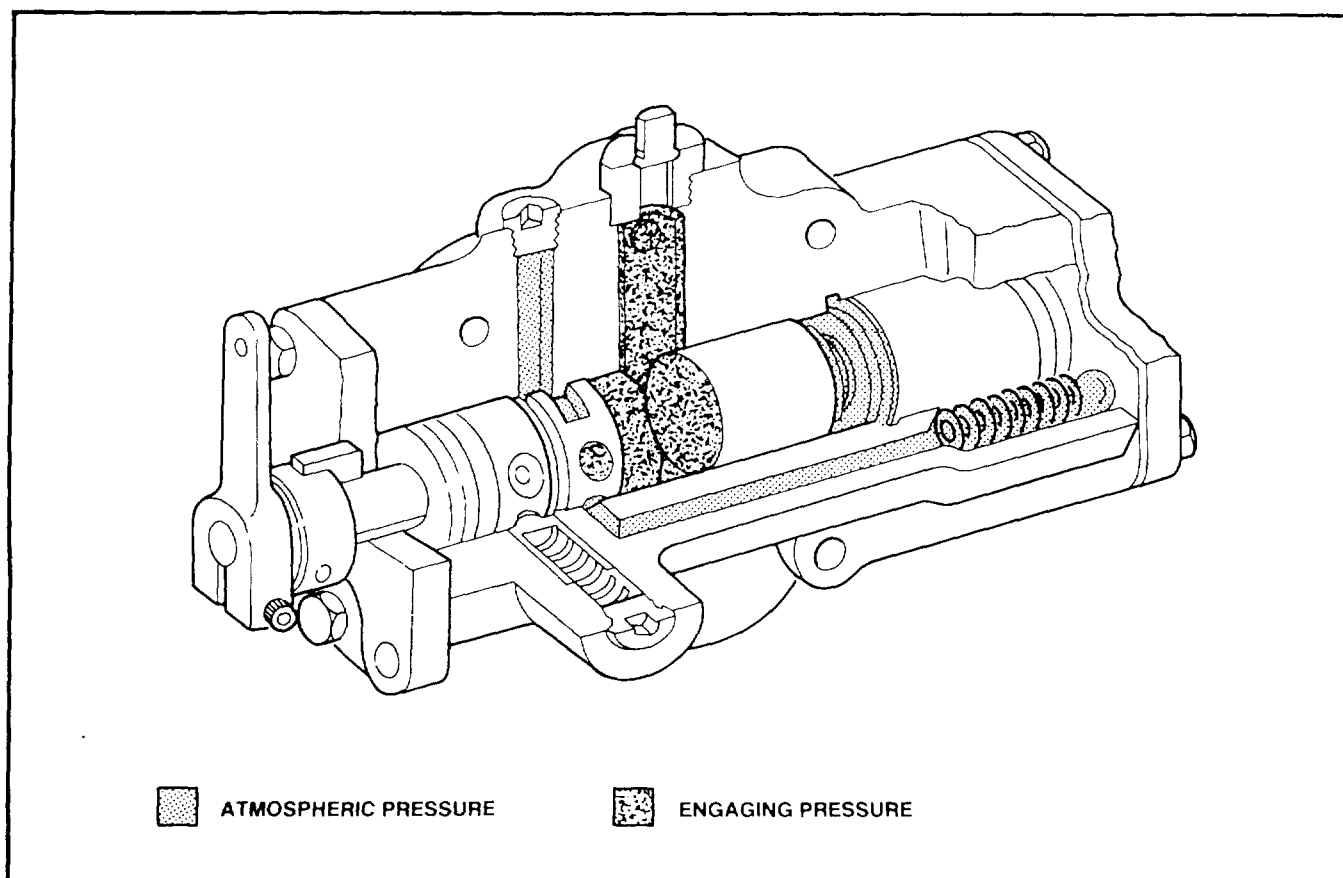


FIGURE D-1: Control Valve - Neutral Cutaway View.

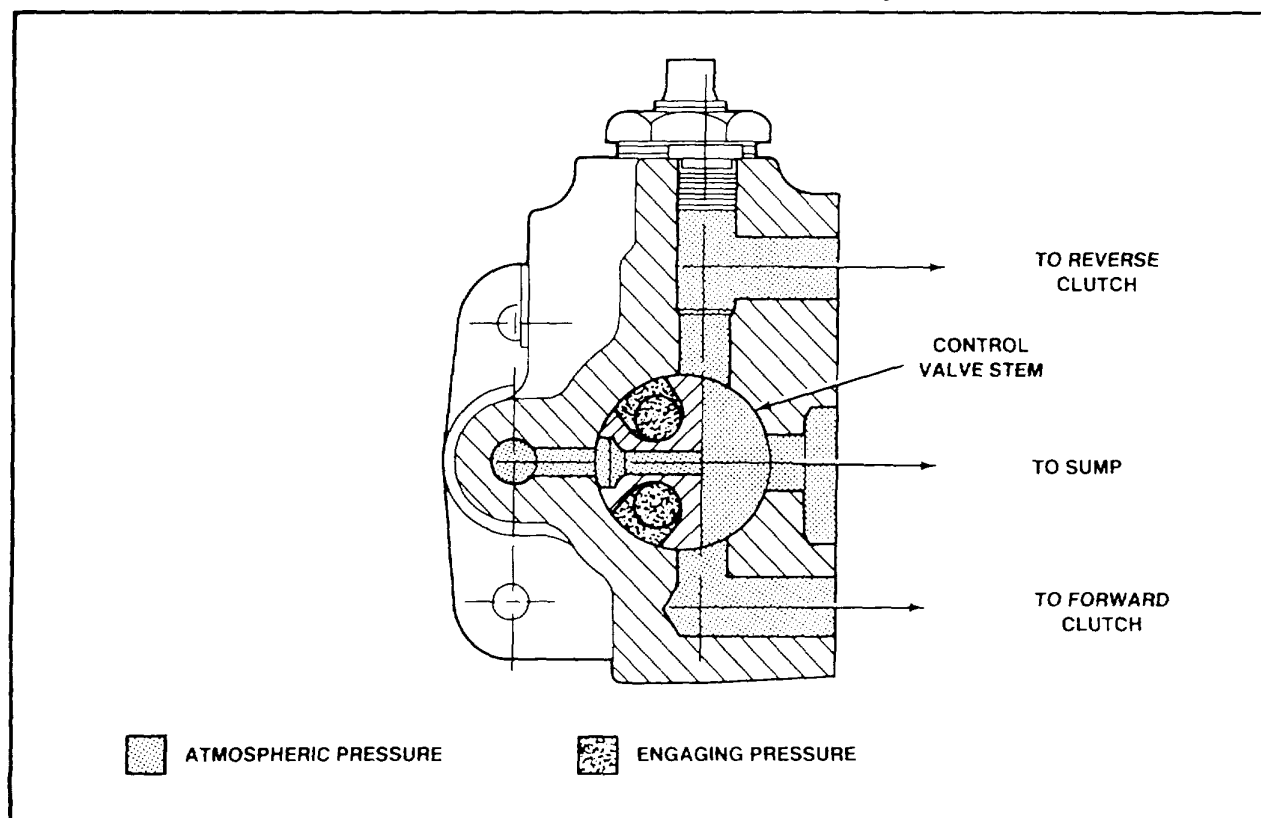


FIGURE D-2: Control Valve - Neutral Sectional View.

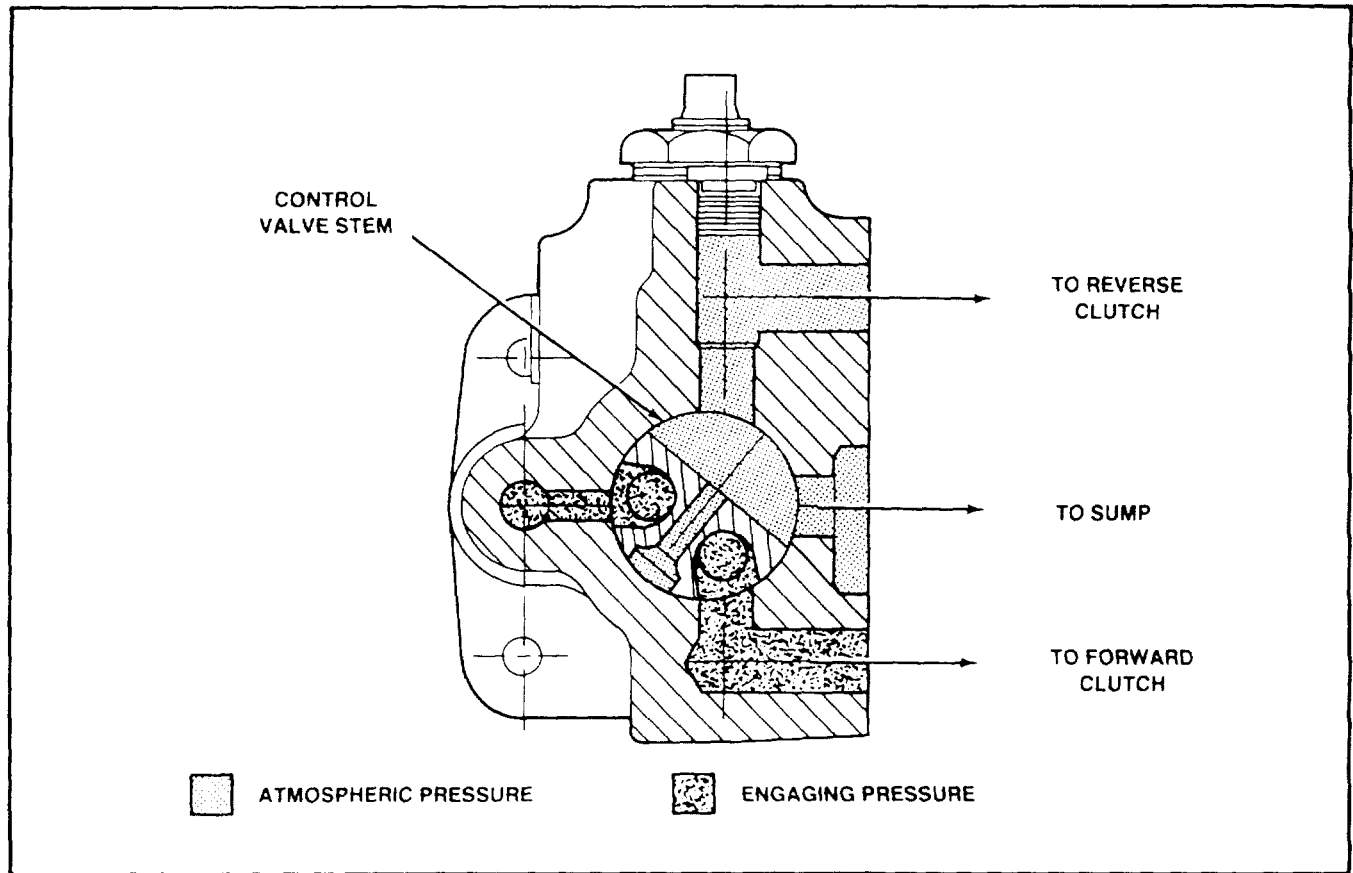


FIGURE D-3: Control Valve - Forward Sectional View.

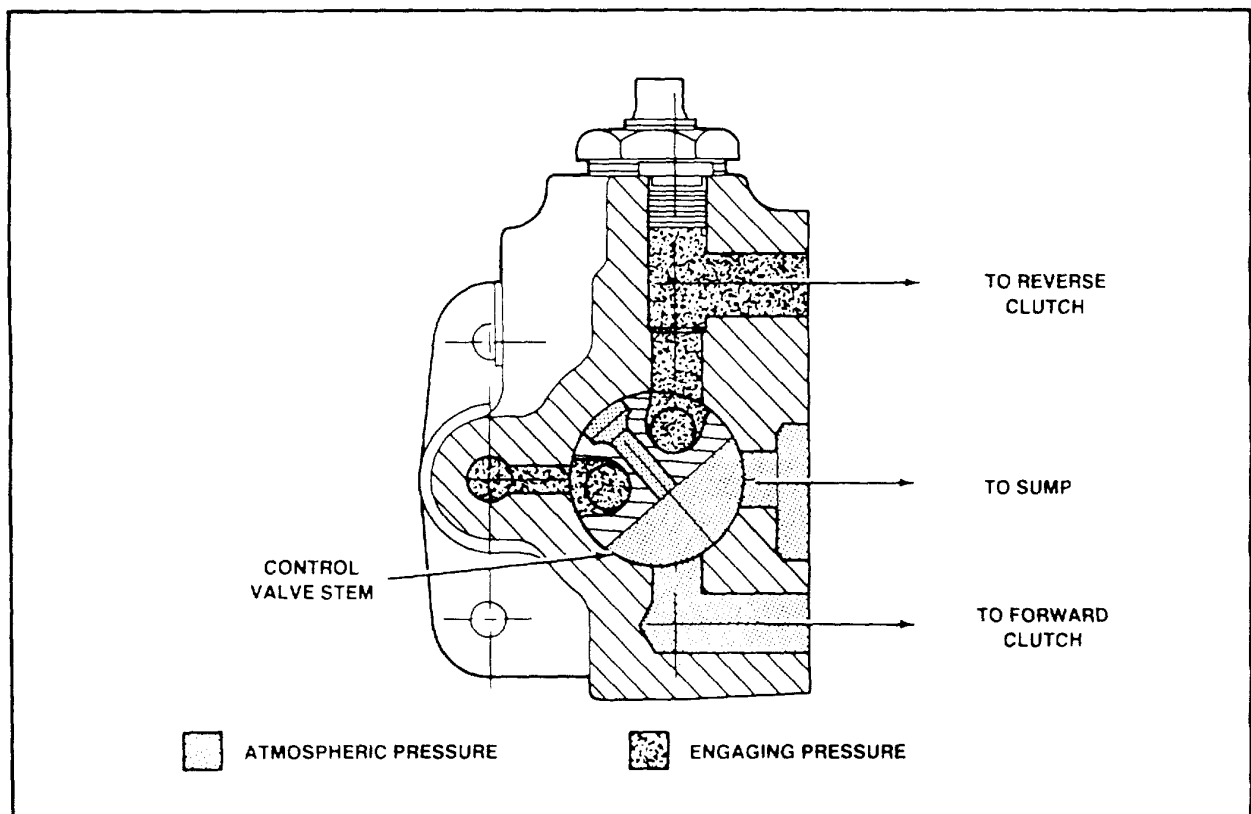


FIGURE D-4: Control Valve - Reverse Sectional View.

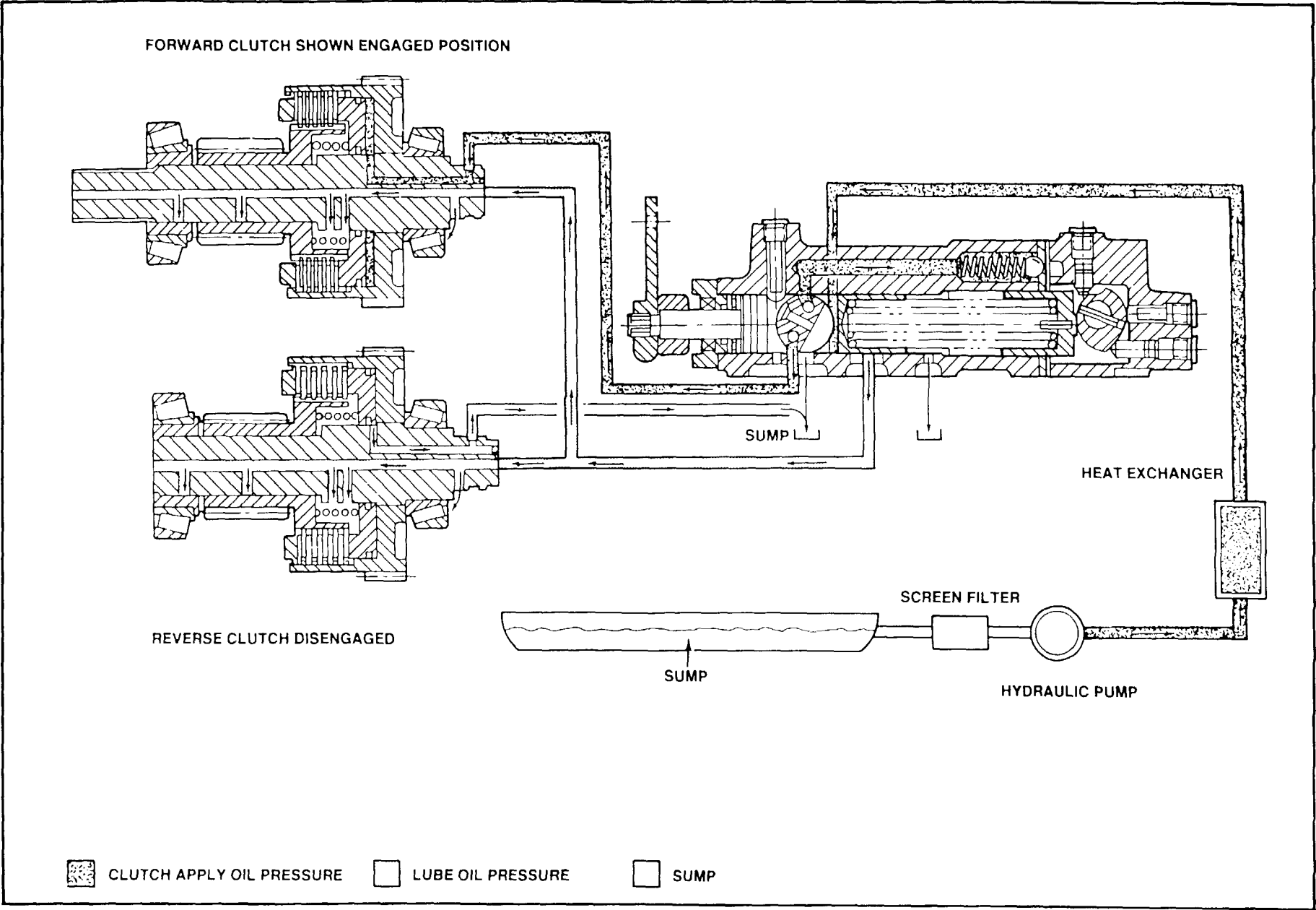


FIGURE D-5: Trolling Mode Oil Flow - Forward Clutch Applied - Schematic Drawing

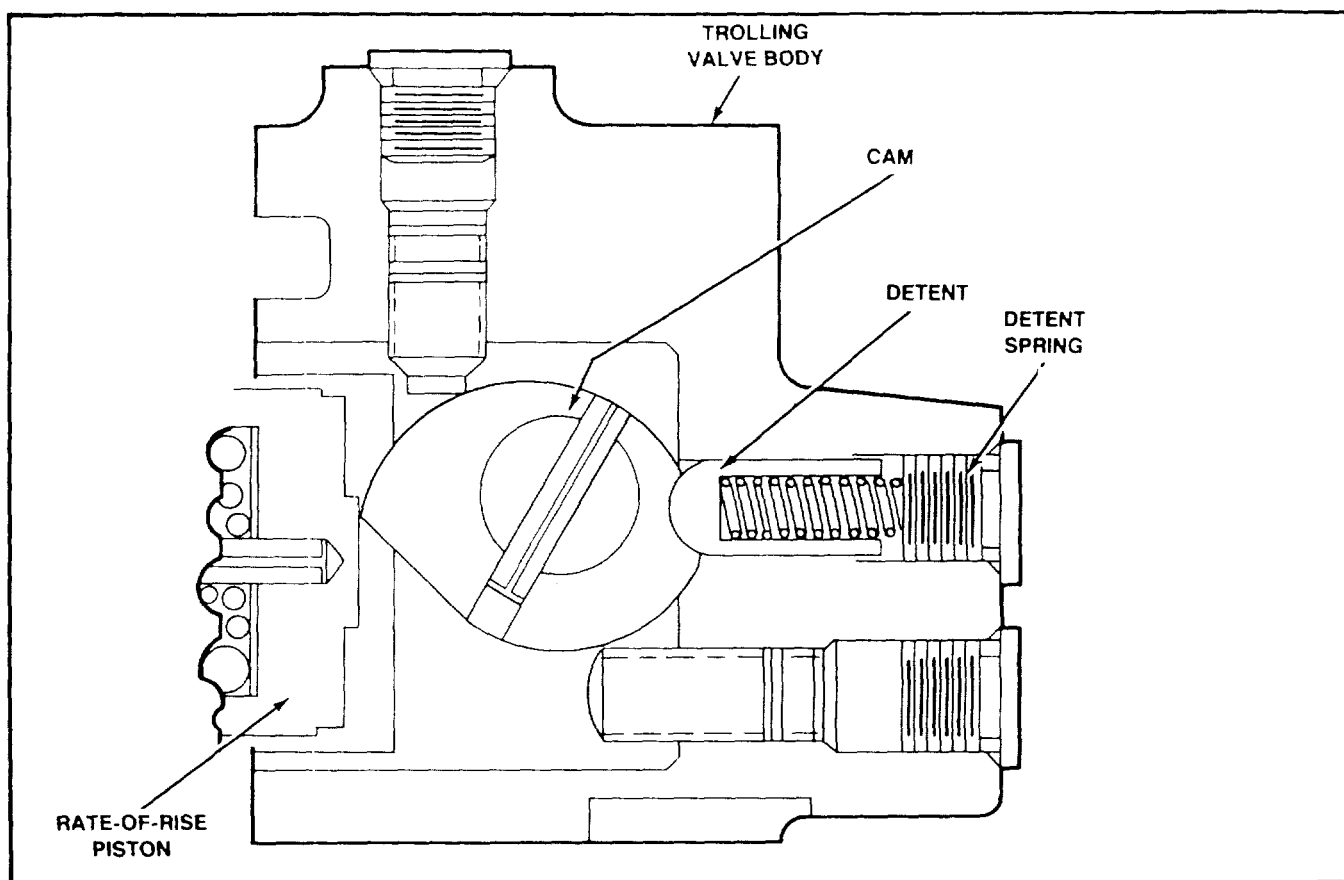


FIGURE D-6: Trolling Valve - Non-trolling Mode.

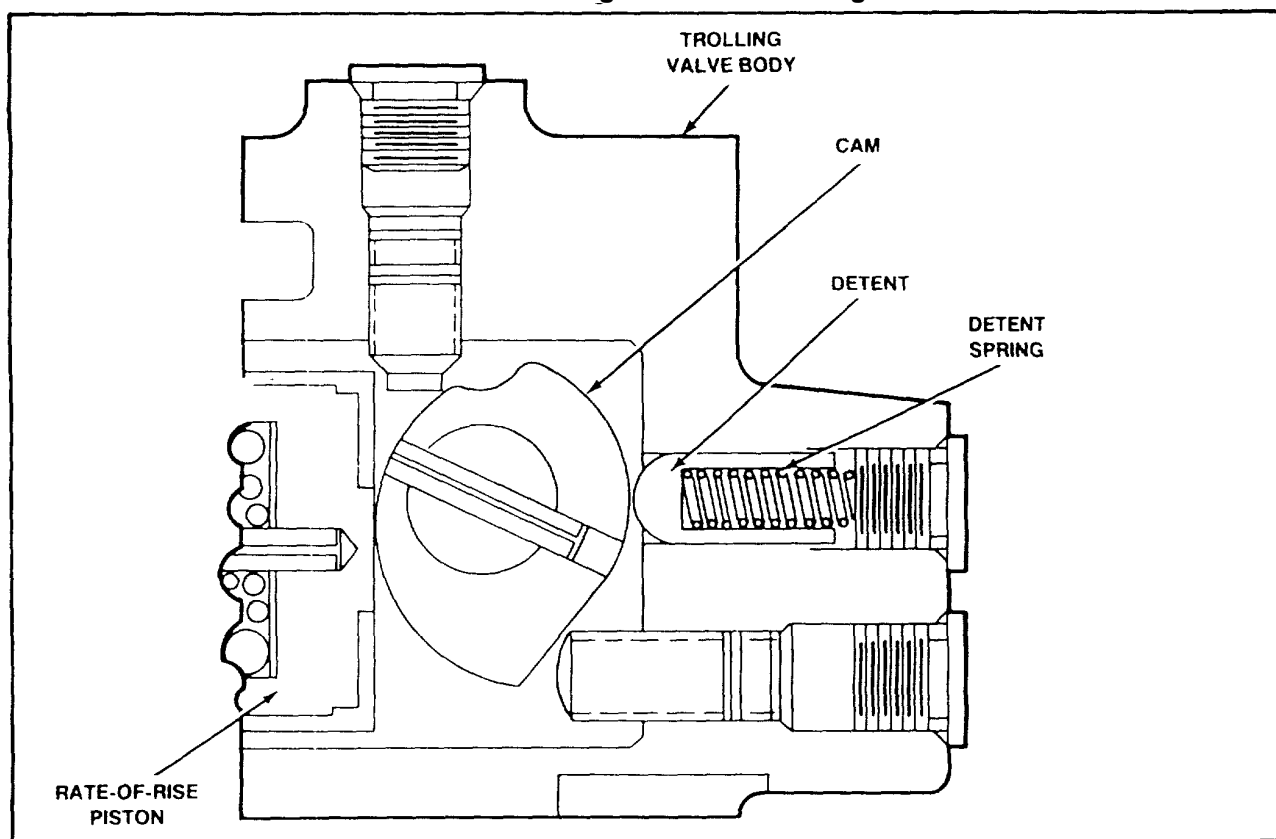


FIGURE D-7: Trolling Valve - Trolling Mode.

PREVENTATIVE MAINTENANCE E

GENERAL**Lubrication**

All moving parts of the marine transmission are lubricated by the oil within the sump as it travels throughout the hydraulic system. The preventive maintenance required to keep the gear functioning properly is slight; however, it is very important that the following directions are observed.

Overhaul Interval

A complete overhaul of the marine transmission should be made at the same time that the engine is overhauled. All parts showing signs of great wear, fatigue, etc., should be replaced at that time.

HYDRAULIC SYSTEM**Oil Capacity and Weight**

See Table 1, of Section B, for oil capacities and grade requirements. This does not include lines to and from the heat exchanger as well as the heat exchanger itself. The oil used in the marine transmission should be of the quality and type recommended on the tag and instruction plate attached to the unit. (See also Table 1. General Information.)

Oil Level

The oil level should be checked daily using the oil level gauge in the marine transmission. Check the oil level with the engine at idle speed and the marine transmission in "Neutral". The oil level must be maintained at the "Full" mark on the oil level gauge.

Output Seal Lubrication - Ratios 3.28 - 4.95:1

Insert No. 2 Lithium based grease for output seal lubrication through lube fitting. Apply grease once a

week if there is water in the bilge. Grease the seals at the same time the oil is changed if the bilge is dry.

Oil Change Interval

The oil must be changed at every other engine oil change. Boats that are placed in dry dock or storage for periods of three months or more, should have the oil changed in the marine transmission prior to a return to active use.

Draining

When a complete oil change of the hydraulic system is required, it is necessary to drain the oil from the heat exchanger and connecting hoses as well as the marine transmission sump. In addition, if the marine transmission is equipped with an oil filter assembly, the filter and connecting hoses must be drained and the filter element replaced. Alternate methods of draining the marine transmission sump of oil are possible as described below:

Gravity Drain

Position a container large enough for sump and external lines oil volume beneath the hex-head pipe plug in the bottom of the rear half housing, and remove the plug. Allow sufficient time for the marine transmission oil to drain from the sump, and then install the plug securely in place.

Suction Drain

A suction pump can be used to drain the marine transmission sump. The oil level gauge tube is serrated to accommodate a suction hose. Remove the oil level gauge, and install a suction hose on the oil level gauge tube. Operate the suction pump until the marine transmission oil has been removed from the sump. After suction draining, remove the pump and hose, and install the oil level gauge in the tube.

Filling

Make certain the drain plug is tight. Use the recommended quality, type, and weight oil, and fill the marine transmission sump with volume and grade specified in Table 1 of Section B. Pour the oil slowly into the breather filler cap. After filling, start the engine and permit the oil to attain proper operating temperature. Shift the marine transmission several times in "Forward" and "Reverse" positions. Check the oil level. With the engine at idle speed and the marine transmission in "Neutral", the oil level must be to the "Full" mark on the oil level gauge.

COMPONENT PARTS

Filter Screen

The filter screen is installed in the manifold assembly, and extends into the marine transmission.

Cleaning Interval

The filter screen should be removed and cleaned at the same time that the oil is changed.

Removal

Remove the cover plate screw, the cover plate, and filter screen from the manifold assembly.

Cleaning

Clean the filter screen in clean diesel fuel insuring that all foreign matter is removed from the holes in the filter screen.

Installation

Install the filter screen in the manifold assembly, and attach the cover to the manifold assembly of the marine transmission with the hex-head capscrew and washer.

Heat Exchanger and Hoses

Disconnect the hoses from the heat exchanger at the same time that the oil is changed. Drain the hoses and the heat exchanger of all oil. After draining, connect the hoses to the heat exchanger.

Oil Filter Assembly

If an oil filter assembly is used in the hydraulic system, the filter and connecting hoses must be drained and the filter element must be replaced. Accomplish these procedures at the same time that the oil is changed.

PERIODIC VISUAL INSPECTION

General

Frequent inspection of the mounting parts of the marine transmission is recommended. Replace any damaged parts.

Heat Exchanger and Oil Filter Connecting Lines

Inspect the heat exchanger and oil filter connecting lines for leaks, sponginess, or other damage. Replace a damaged line.

Pressure and Temperature Gauge Assemblies

Periodically inspect the pressure and temperature gauge assemblies for damage. Replace a damaged gauge. If a gauge is suspected of being inaccurate, replace the gauge with one of proven accuracy.

GENERAL

This section of the maintenance manual has been prepared to assist maintenance personnel in locating faults in the marine transmission. When investigating these faults, always remember to consider the entire power package.

PRESSURE AND TEMPERATURE CHECKS

Main Pressure

The main pressure, which is used to apply the clutches, can be checked by installing a pressure gauge with a range of 0 to 400 psi based on springs used in the hydraulic system at the pressure pick-up point (1/4-1 8 NPTF thread) of the selector valve. Normally, the main pressure should be between 220 to 240 psi at 1800 rpm engine speed and 180 degrees F. temperature, and not less than 225 psi minimum (depending on springs used) at cruising speed.

Cooling and Lubrication Pressure

The lubrication and cooling pressure is the overage oil from the clutch pressure regulator valve in the selector

valve assembly. No pressure check is specified. The pressure varies from 1.5 psi minimum to 16 psi maximum which is ample for the marine transmission lubrication.

Temperature

The temperature of the oil can be checked by installing a temperature gauge with a range of 0 degrees to 300 degrees F. in the hydraulic system, in the line between the oil pump assembly and the heat exchanger. Thus, temperature readings taken will closely reflect the temperature of the oil within the marine transmission sump. Readings taken should register between 150 degrees F. and 180 degrees F. 210 degrees F. is maximum and 150 degrees F. minimum recommended operating temperatures.

TROUBLE SHOOTING CHART

The trouble shooting chart (Table 2) is organized in three columns. Proper use of the chart will aid in the rapid determination and repair of any functional difficulties that may occur.

TABLE 2. TROUBLE SHOOTING

SYMPTOM	CAUSE	REMEDY
1. Low Oil Pressure AND/OR Low Lube Pressure	1-1. Improper oil fill. 1-2. Plugged filter/strainer. 1-3. Air leak, suction side. 1-4. Selector valve. 1-5. Damaged seals/piston rings. 1-6. Worn pump.	1-1. Drain/fill as required. 1-2. Clean/replace filter/strainer. 1-3. Inspect/replace internal/external oil lines. 1-4. See selector valve table. 1-5. Tear down unit to inspect/replace seals/piston rings. 1-6. Check oil flow, replace as required.

TABLE 2. TROUBLE SHOOTING (cont.)

SYMPTOM	CAUSE	REMEDY
1. Low Oil Pressure AND/OR Low Lube Pressure	1-7. Broken pump drive.	1-7. Replace pump drive.
	1-8. Improper linkage adjustment.	1-8. Adjust linkage.
2. High Main Pressure	2-1. Selector valve.	2-1. See selector valve table.
	2-2. Blocked passages.	2-2. Tear down unit to inspect/clear passages.
3. High Oil Temperature	3-1. Improper oil fill.	3-1. Drain/fill as required.
	3-2. Worn bearings.	3-2. Replace bearings.
	3-3. Insufficient cooling.	3-3. Check external lines for blockage; check thermostat bypass (if equipped).
	3-4. Slipping clutch	3-4. Worn clutches, low oil pressure.
	3-5. Improper oil	3-6. Replace with correct grade.
	3-6. Oil cooler fouling	3-6. Check cooler for blockage, scaling. Repair or replace cooler.
4. Low Oil Temperature	4-1. Overcooling.	4-1. Add thermostatic bypass. Re-size cooling system.
5. Excessive Noise AND/OR Vibration	5-1. Improper oil fill.	5-1. Drain/fill as required.
	5-2. Worn input coupling/blocks.	5-2. Replace coupling/blocks.
	5-3. Worn bearings.	5-3. Replace bearings.
	5-4. Improper bearing adjustment.	5-4. Adjust bearing endplay.
	5-5. Worn gears.	5-5. Replace gears.
	5-6. Alignment.	5-6. Check/adjust transmission and shaft alignment.
	5-7. Torsional activity.	5-7. Have torsional study performed.
	5-8. Improper mounting.	5-8. Check integrity of mounting.
6. No Neutral	6-1. Improper linkage adjustment.	6-1. Adjust linkage.
	6-2. Selector valve.	6-2. See selector valve table.
	6-3. Clutch failure.	6-3. Repair/replace clutch.

TABLE 2. TROUBLE SHOOTING (cont.)

SYMPTOM	CAUSE	REMEDY
7. Harsh Engagement	7-1. Improper linkage adjustment.	7-1. Adjust linkage.
	7-2. Wrong oil.	7-2. Replace with correct grade.
	7-3. Warped clutch plates.	7-3. Repair/replace clutch.
	7-4. Selector valve.	7-4. See selector valve table.
8. No Output Power	8-1. Broken shaft.	8-1. Replace shaft.
	8-2. Improper oil fill.	8-2. Drain, fill as required.
	8-3. Clutch failure.	8-3. Repair/replace clutch.
	8-4. Selector valve.	8-4. See selector valve table.
9. High Lube Pressure	9-1. Damaged seals/piston rings.	9-1. Tear down unit to inspect/replace seals/piston rings.
	9-2. Blocked passages.	9-2. Tear down unit to inspect/clear passages.
10. Selector Valve Table	10-1. Scored valve bore.	10-1. Replace valve body.
	10-2. Broken/collapsed spring(s).	10-2. Replace spring (s).
	10-3. Blocked orifices.	10-3. Disassemble and clean.
	10-4. Stuck regulator piston.	10-4. Blockage, scored faces.
	10-5. Cut/damaged O-rings.	10-5. Replace as needed.
	10-6. Scored valve stem.	10-6. Replace valve stem.
	10-7. Stuck rate-of-rise piston.	10-7. Disassemble and repair/replace as required.
	10-8. Damaged orifice plate.	10-8. Replace orifice plate.
	10-9. Steel ball at rate-of-rise not seated properly.	10-9. Replace as required.
	10-10. Pressures out of range.	10-10. Valve shimming as required.

PRIOR TO REPLACEMENT**General**

If it becomes necessary to replace the bearing retainer oil seal (Fig. O-5 Item 6) because of leakage, this can be accomplished without removing the marine transmission from the engine by following the procedure below.

Draining

In most installations, it will be necessary to drain the marine transmission sump of oil in order to accomplish oil seal replacement. Drain the oil by following the procedure described in Section E, Hydraulic System, Draining.

Output Flange Clearance

Scribe an aligning mark across the outside diameter of the output flange (Fig. O-5 Item 5) and the companion flange for installation purposes. Remove the bolts and nuts that secure the companion flange to the output flange. Slide the propeller shaft rearward until there is sufficient clearance for the removal of the output flange.

OIL SEAL REPLACEMENT - RATIOS 1.12 - 3.10:1**Removal**

Remove the three capscrews (Fig. O-5 Item 1) securing the output flange (Fig. O-5 Item 5) as well as the retaining washer (Fig. O-5 Item 2), lathe cut ring (Fig. O-5 Item 4), and shims (Fig. O-5 Item 3) (see Figure G-1). Discard the rectangular ring.

Using a portable hydraulic power set and puller legs (see Figure G-2), remove the output flange (Fig. O-5 Item 5).

Remove oil seal (Fig. O-5 Item 6) from the output seal carrier. Discard the oil seal.

Installation

Install a new oil seal (Fig. O-5 Item 6) in the output seal carrier (Fig. O-5 Item 8). The oil seal must be installed flush with the rear face of the output seal carrier, and the lip of the oil seal must point towards the output gear (Fig. O-5 Item 13).

Install the output flange (Fig. O-5 Item 5) being careful not to damage the oil seal when engaging the spline of the flange. This operation has to be done using special tool TD-300389 and a 10 ton hydraulic ram pressed to 7 tons/max. (see Figure G-3).

Measure the gap from the shoulder of output flange (Fig. O-5 Item 5) on which the retainer washer rests on to the end of the output shaft (Fig. O-5 Item 12). (see Figure G-4).

Add shims (Fig. O-5 Item 3) .003 to .006 inch thinner than the gap.

Install new lathe cut ring (Fig. O-5 Item 4) retainer washer (Fig. O-5 Item 2).

Secure the retainer washer (Fig. O-5 Item 2) with three capscrews (Fig. O-5 Item 1) torqued to 65 lb.-ft.

AFTER REPLACEMENT**General**

After replacement of the oil seal (Fig. O-5 Item 6) has been carried out, and the output shaft end play has been verified as being correct, the following procedures of drive line connection and oil filling of the marine transmission sump can be completed.

Drive Line Connection

Slide the propeller shaft and the companion flange forward against the output flange (Fig. O-5 Item 5). Align the scribed marks on the companion flange and the output flange. Secure the flanges together with the bolts and nuts previously removed.

Filling

Fill the marine transmission sump with oil by following the procedure described in Section E, Hydraulic System, Gravity Drain.

OIL SEAL REPLACEMENT - RATIOS 3.28 - 4.95:1

Removal

Remove the three capscrews securing the output flange (Fig. O-6 Item 5), as well as the retaining washer (Fig. O-6 Item 2), lathe cut ring (Fig. O-6 Item 4), and shims (Fig. O-6 Item 3) (see Figure G-1). Discard the rectangular ring.

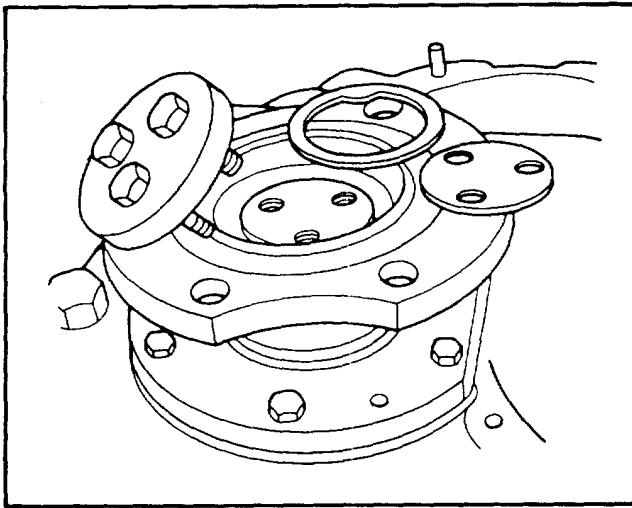


FIGURE G-1: Output flange, retainer washer and rubber ring removed.

Using a portable hydraulic power set and puller legs (see Figure G-2), remove the output flange (Fig. O-6 Item 5).

Remove oil seals (Fig. O-6 Item 6) from the output seal carrier (Fig. O-6 Item 8). Discard the oil seals.

Installation

Install two new oil seals (Fig. O-6 Item 6) in the output seal carrier (Fig. O-6 Item 8). The lip of the outer seal must point towards the output flange and the lip of the inner seal must point towards the output gear. The inner seal must be installed such that when both oil seals are installed, a gap of approximately 1/4 inch exists between the two seals. The rear face of the outer seal must be flush with the rear face of the output seal carrier.

Install the output flange being careful not to damage the oil seals when engaging the spline of the flange. This operation has to be done using special tool TD-300389 and a 10 ton hydraulic ram pressed to 7 tons/max. (see Figure G-3).

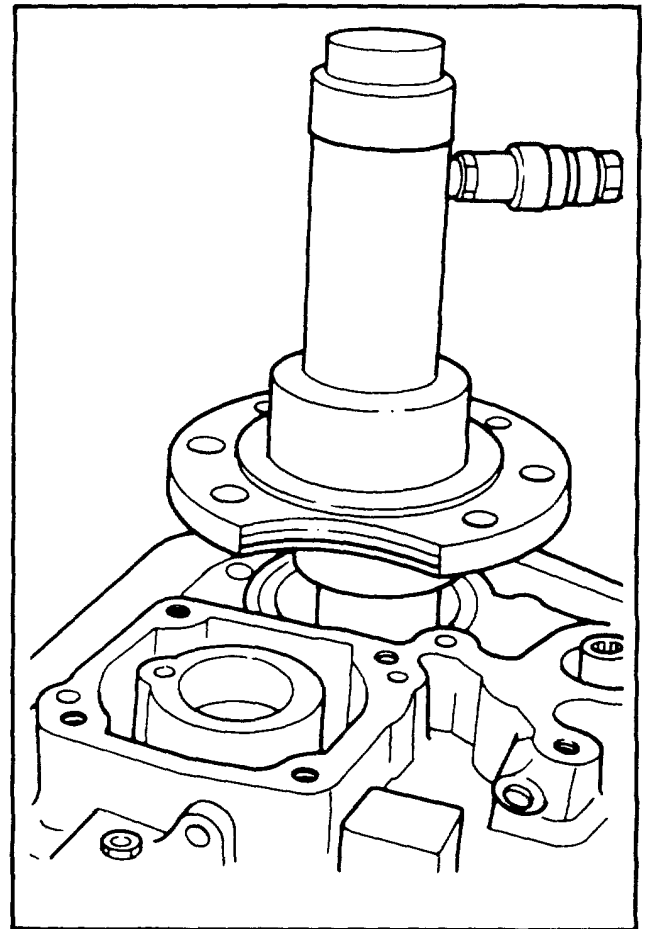


FIGURE G-2: Removing output flange.

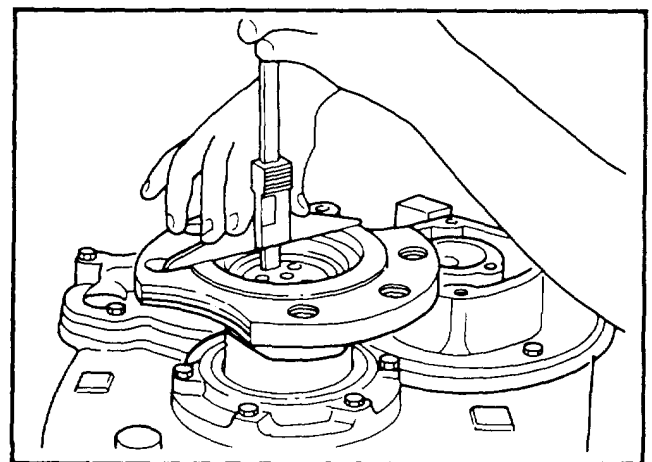


FIGURE G-3: Using hydraulic press with tool TD-300389.

Measure the gap from the shoulder of the output flange (Fig. O-6 Item 5) on which the retainer washer rests onto the end of the output shaft (Fig. O-6 Item 14). (see Figure G-4).

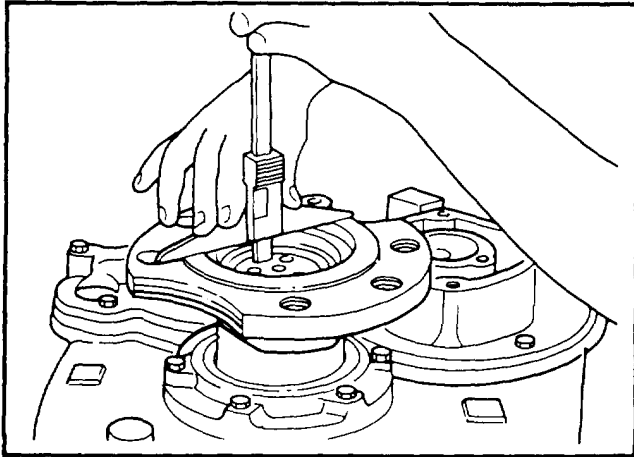


FIGURE G-4: Measurement of gap.

Add shims (Fig. O-6 Item 3) .003 to .006 inch thinner than the gap.

Install new lathe cut ring (Fig. O-6 Item 4) retainer washer (Fig. O-6 Item 2).

Secure the retainer washer with three capscrews (Fig. O-6 Item 1) torqued to 65 lbs. ft.

Insert grease between the oil seals (Fig. O-6 Item 6) through the grease fitting (Fig. O-6 Item 9). Add enough grease just to fill the gap between the two oil seals. Use No. 2 Lithium based grease.

PRIOR TO REMOVAL**Hydraulic System**

Drain the hydraulic system of oil (Section E, Hydraulic System, Draining).

Connecting Linkage

Disconnect all connecting linkage and lines to the marine transmission.

Support

Support the marine transmission with a hoist, or other suitable equipment, prior to the removal of any mounting parts.

LIFTING BOLT HOLES PROVIDED ON DDC PRODUCTS

Most DDC products have provisions for attaching lifting bolts. The holes provided are always of adequate size and number to safely lift the DDC product.

These lifting points should not be used to lift the complete power unit. Lifting excessive loads at these points could cause failure at the lift point (or points) and result in damage or personal injury.

REMOVAL**Output Flange**

Scribe an aligning mark across the outside diameter of the output flange and the companion flange for installation purposes. Remove the bolts and nuts that attach the output flange to the companion flange. After the removal of attaching parts, move the propeller shaft rearward until there is sufficient clearance for marine transmission removal.

Engine Bedrail Connections

Disconnect the mounting brackets installed on the engine bedrails from the mounting pads of the marine transmission or from the engine bedrails.

Engine Connection

Remove the hex-head capscrews that secure the housing of the marine transmission to the engine flywheel housing. Slide the marine transmission rearward until the rubber blocks on the drive spider are clear of the driving ring installed on the engine flywheel. In the case of Torsional Coupling equipped DD-5111V's, slide the marine transmission rearward until the input shaft is clear of the coupling hub. Remove the marine transmission. Remove the driving ring from the engine flywheel only if its replacement is necessary. Remove the Torsional Coupling for inspection.

MISCELLANEOUS EXTERNAL PARTS

Remove spider drive (Figure O-3 Item 33) or Torsional Coupling (Figure O-3 Item 37) off splined input shaft (Figure O-3, Item 8) (Figure I-1).

The hydraulic oil pump can be installed to accommodate right and left hand engines. Place indexing marks on oil pump and manifold assembly to assure proper orientation when re-installing. Incorrect installation will lead to transmission failure. Do not remove pipe plugs from the oil pump after it has been removed. Improper installation of pipe plugs can route oil flow incorrectly. Oil pump is serviceable as an assembly only.

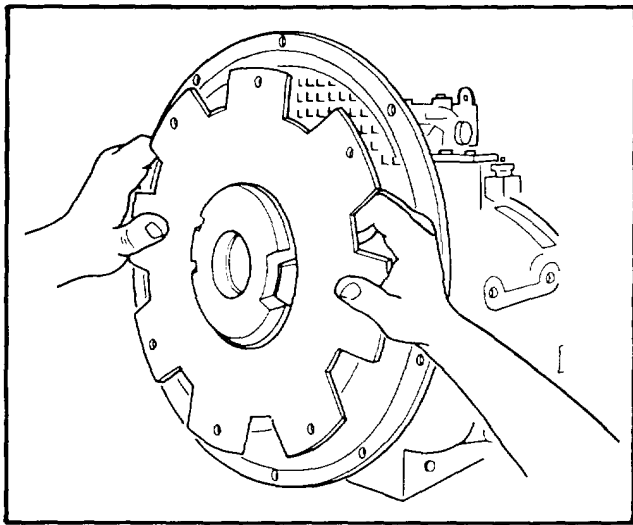


FIGURE I-1: Removing or installing Torsional Coupling.

Remove four capscrews (Figure O-1 Item 1) securing the oil pump (Figure O-1 Item 2) to the manifold assembly (Figure O-1 Item 29) (Figure I-2). Remove the oil pump (Figure O-1 Item 2) and gasket (Figure O-1 Item 3) (Figure I-3).

Remove four capscrews (Figure O-1 Item 5) that secure the selector valve assembly (Figure O-1 Item 4) to the main housing (Figure O-1 Item 17) (Figure I-4).

Remove the selector valve assembly (Figure O-1 Item 4) and gasket (Figure O-2 Item 18).

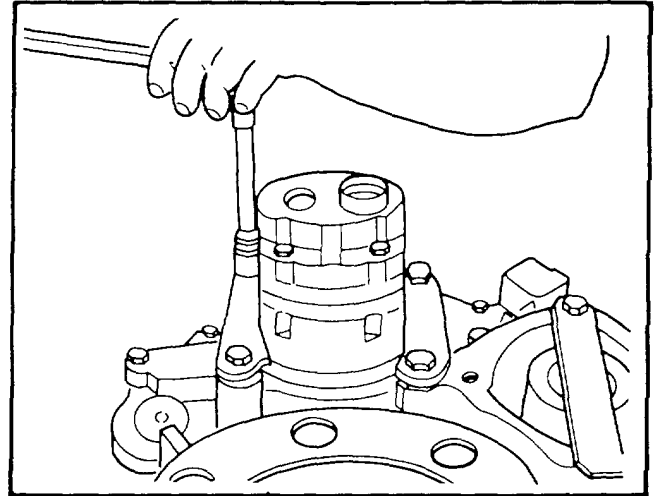


FIGURE I-2: Removing or installing hydraulic pump retaining capscrews.

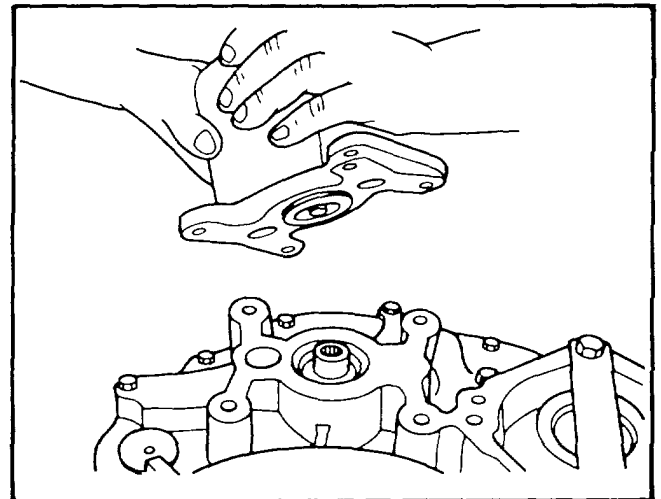


FIGURE I-3: Hydraulic pump removed.

Remove capscrew (Figure O-1 Item 33) securing the clamp plate (Figure O-1 Item 34) to the manifold assembly (Figure O-1 Item 29) Insert a 3/8-16 UNC eyebolt into the tapped hole provided in plug (Figure O-1 Item 35) to facilitate removal (Figure I-5). Remove the filter screen (Figure O-1 Item 36) (Figure I-6).

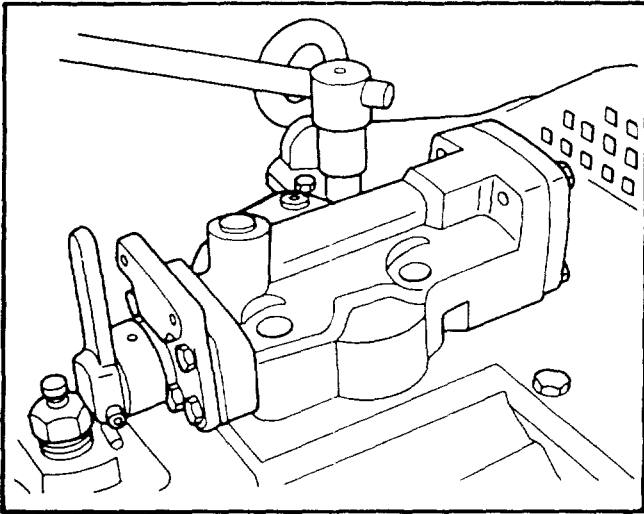


FIGURE I-4: Removing selector valve assembly.

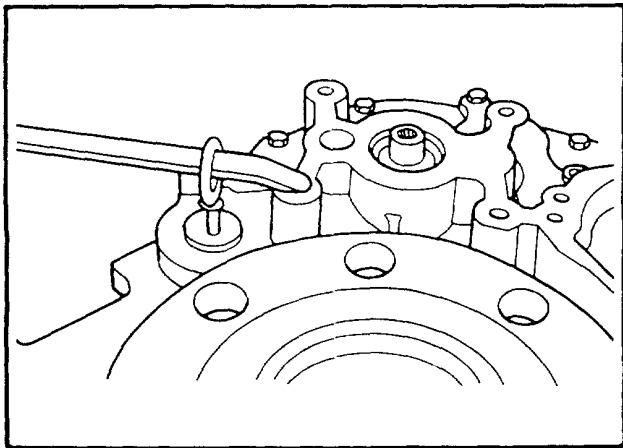


FIGURE I-5: Removing of screen cover filter.

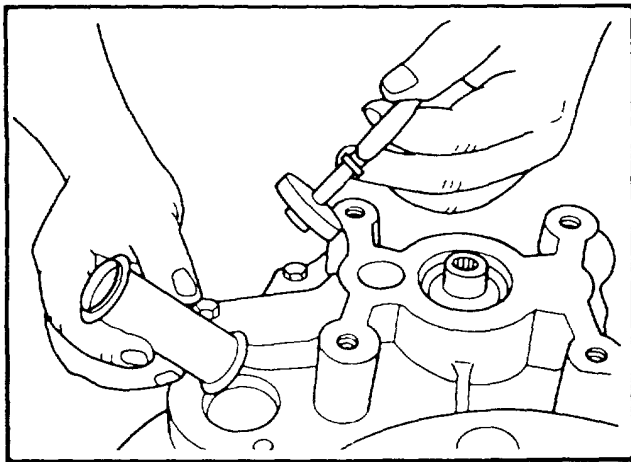


FIGURE I-6: Removing or installing screen filter.

Remove oil level gauge (Figure O-1 Item 43). Remove tube assembly (Figure O-1 Item 42).

Remove the capscrews (Figure O-5 Item 1) securing the output flange (Figure O-5 Item 5) to the output shaft (Figure O-5 Item 12). Remove the retainer washer (Figure O-5 Item 2), shims (Figure O-5 Item 3), and the lathe cut ring (Figure O-5 Item 4) (Figure I-7). Using a portable hydraulic ram and puller legs, remove the output flange (Figure I-8).

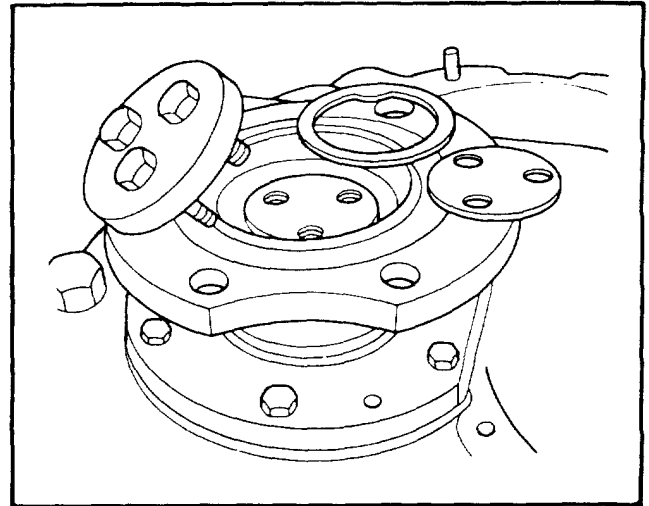


FIGURE I-7: Output flange retainer washer and lathe cut ring removed.

FORWARD AND REVERSE CLUTCH GROUP OF PARTS

Remove the capscrews (Figure O-1 Items 23, 24) securing the manifold assembly (Figure O-1 Item 29) to the main housing (Figure O-1 Item 17) (Figure I-9). Using the 3/8-16 tapped holes in the manifold assembly, separate it from the main housing. Use the same procedure to separate the bearing carrier (Figure O-1 Item 31) from the main housing (Figure I-10).

Remove the wear sleeve (Figure O-4 Item 9) on the reverse clutch shaft (Figure O-4 Item 101) by prying (Figure I-11).

NOTE

If wear sleeve is tight, remove by placing a dull chisel across the wear sleeve and rapping sharply with a hammer. Rotate the shaft and rap again. The wear sleeve should expand which allows easy removal.

Remove the pump drive pin (Figure O-4 Item 11) from the reverse shaft (Figure O-4 Item 10) and remove pump drive adapter (Figure O-4 Item 8).

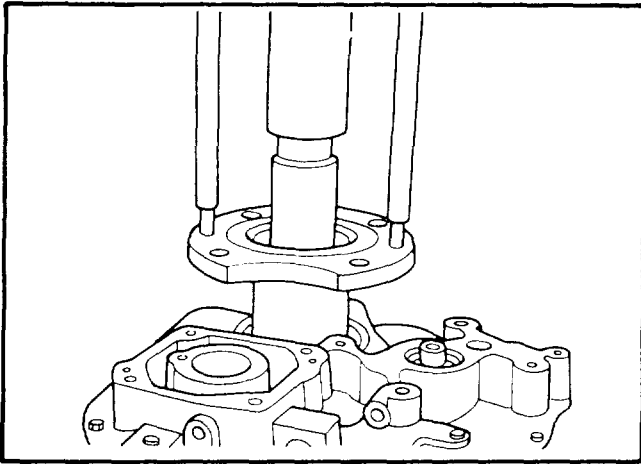


FIGURE I-8: Removing output flange.

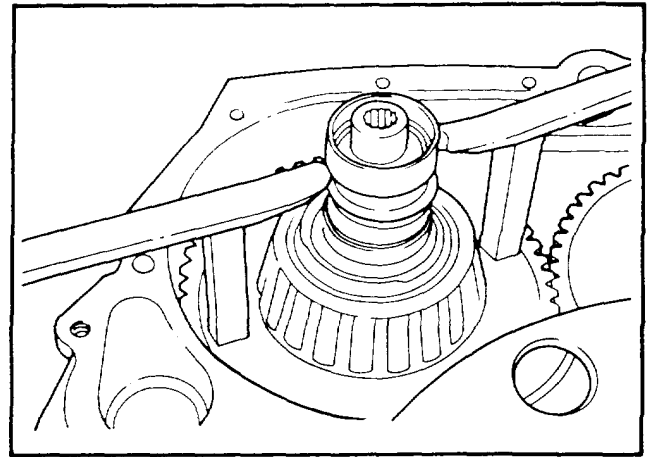


FIGURE I-11: Removing of wear sleeve.

Remove piston rings (Figure O-3 Item 1) (Figure O-4 Item 1) from the end of the clutch shafts (Figure O-3 Item 8) (Figure O-4 Item 10). With the aid of special lifting tool TD-300426, remove the clutches from the main housing (Figure O-1 Item 17) (Figure I-12).

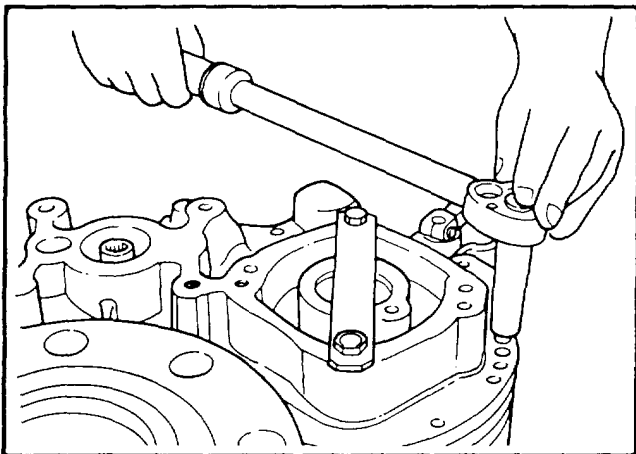


FIGURE I-9: Removing or installing capscrew on manifold assembly.

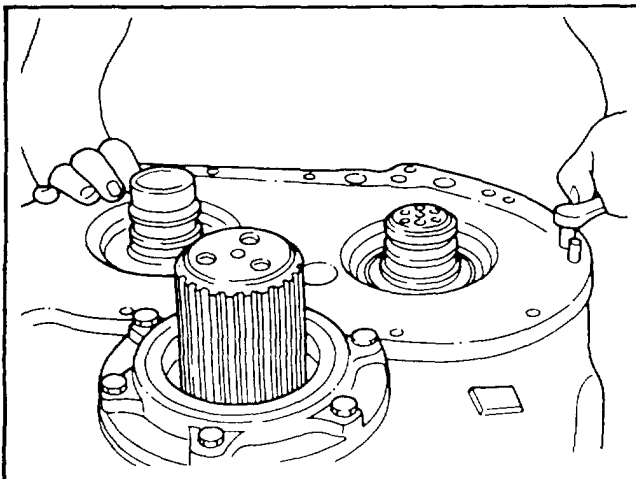


FIGURE I-10: Removing of bearing carrier.

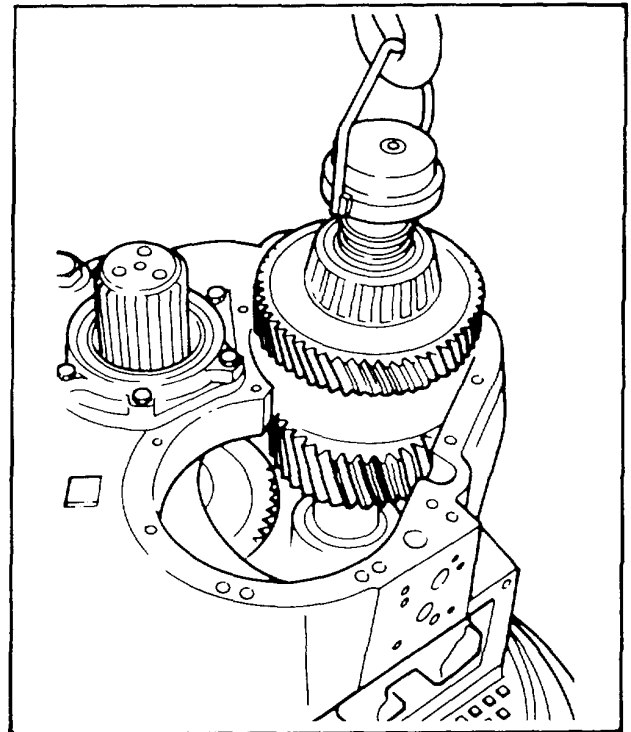


FIGURE I-12: Removing or installing reverse clutch group.

NOTE

The bearing carriers at the end of the clutch shafts may remain in the main housing when the clutch assemblies are lifted. Remove bearing outer races only if replacement is necessary.

The following procedure describes the disassembly of the forward clutch group of parts. The procedure for the disassembly of the reverse clutch group of parts is similar.

Support the forward clutch assembly on bench with the input side up. Place a cupped steel spacer over the end of the clutch shaft (Figure O-3 Item 8) to prevent damage. Carefully position a bearing puller on the shaft and remove the bearing inner race (Figure O-3 Item 30) and bearing carrier (Figure O-3 Item 29) (Figure I-13).

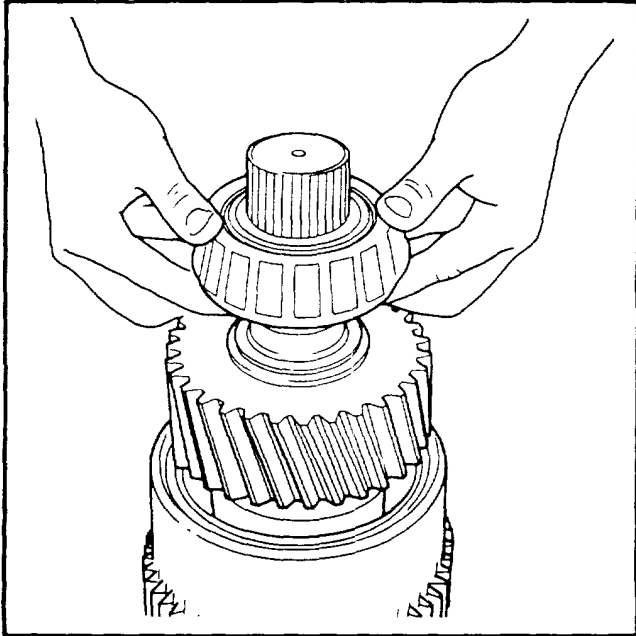


FIGURE I-13: Removal of bearing carrier.

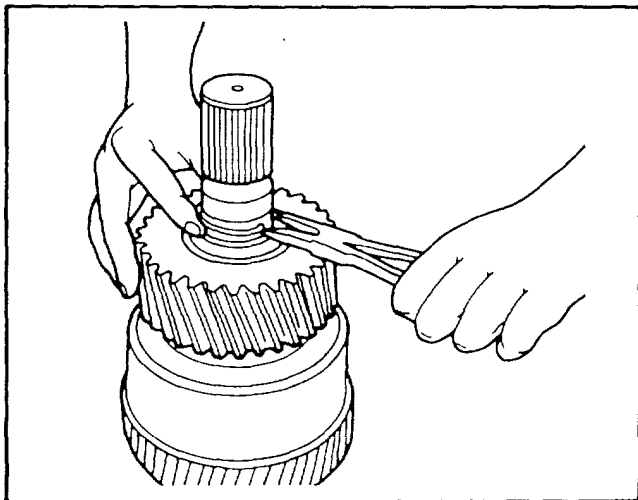


FIGURE I-14: Removal or installation of snap ring.

Remove snap ring (Figure O-3 Item 28) (Figure I-14). Remove the forward pinion (Figure O-3 Item 24) (Figure I-15). Remove thrust race (Figure O-3 Item 27, 25) and thrust bearing (Figure O-3 Item 26) (Figure I-16).

Remove the rear thrust bearing (Figure O-3 Item 22) and races (Figure O-3 Items 21,23) (Figure I-17).

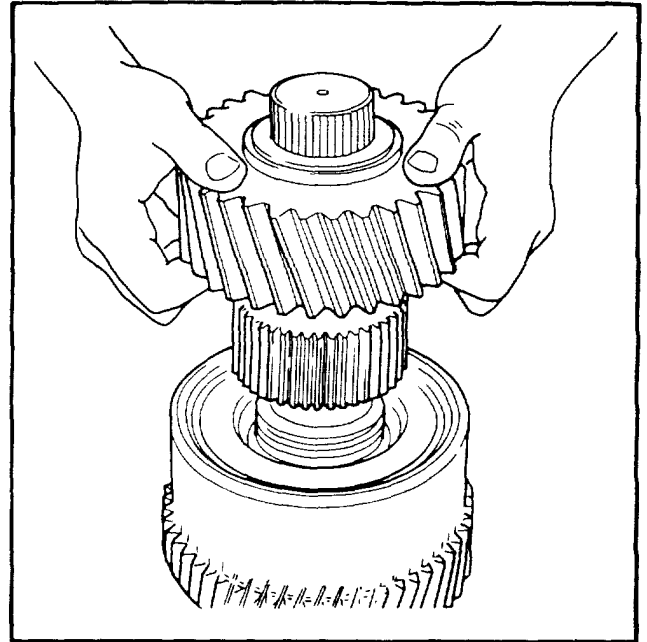


FIGURE I-15: Removing or installing pinion on clutch shaft.

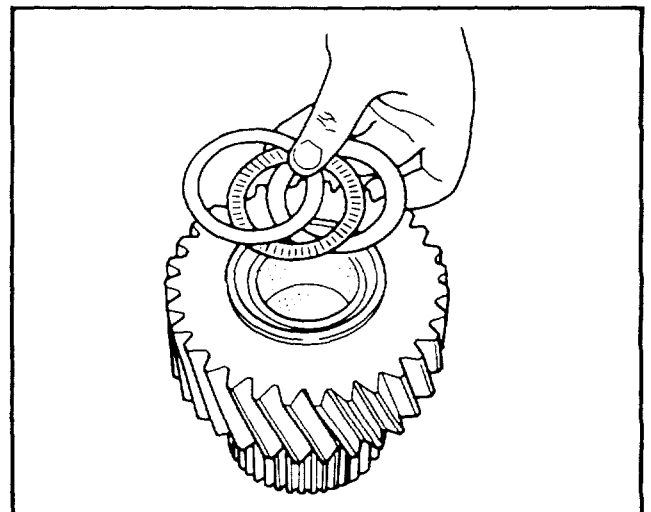


FIGURE I-16: Front thrust needle bearing and thrust races removed.

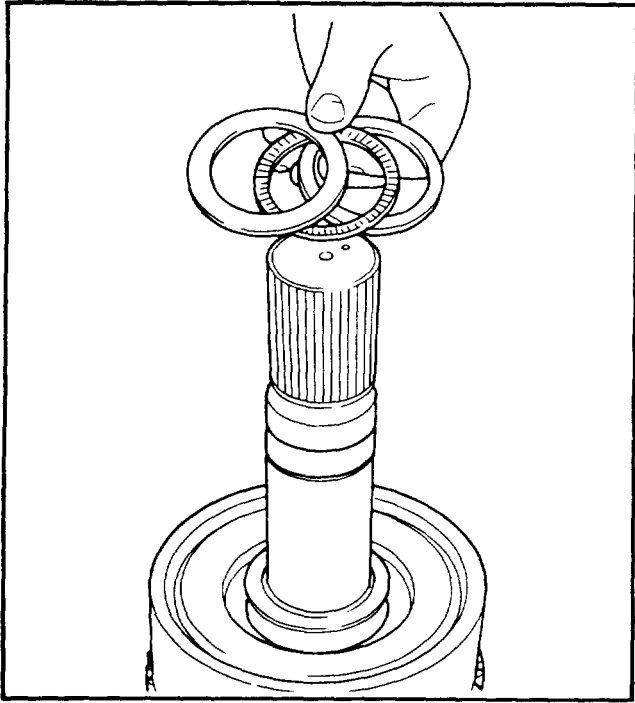


FIGURE I-17: Rear thrust needle bearing and thrust races removed.

Remove the internal snap ring (Figure O-3 Item 17) from inside of the forward clutch housing (Figure O-3 Item 8). Remove the clutch backplate (Figure O-3 Item 16) (Figure I-18). Remove the clutch plates (Figure O-3 Items 13,14,15) (Figure I-19).

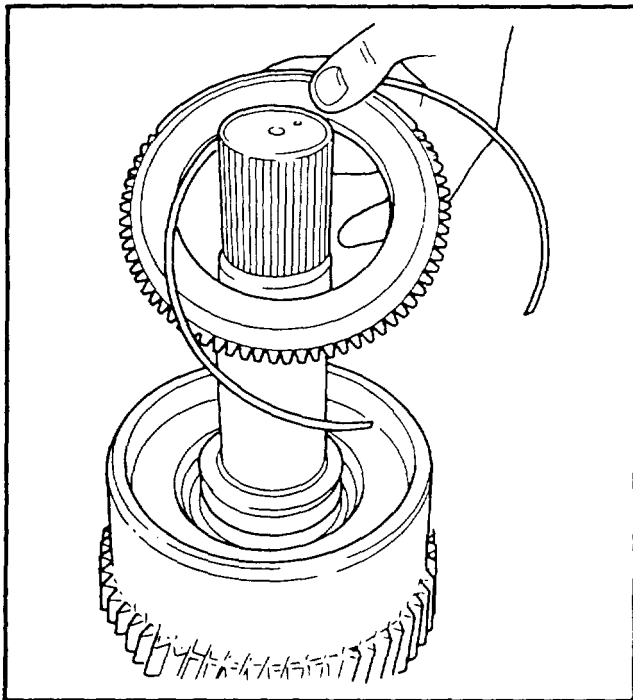


FIGURE I-18: Clutch backplate and snap ring removed.

Place special tool TD-300421 over the clutch return spring (Figure O-3 Item 18) (Figure I-20). Use a hydraulic ram to press tool downward and compress the spring enough to remove the snap ring (Figure O-3 Item 20) from the shaft (Figure I-21).

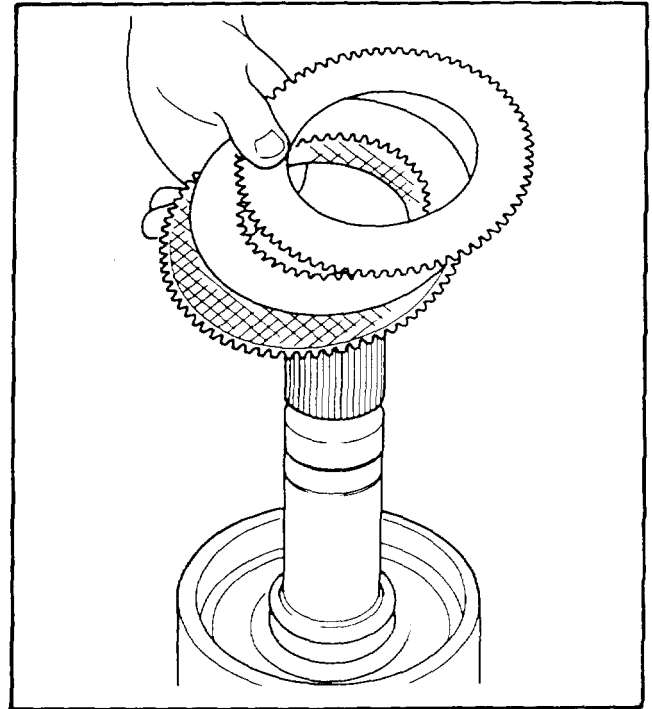


FIGURE I-19: Clutch plates removed.

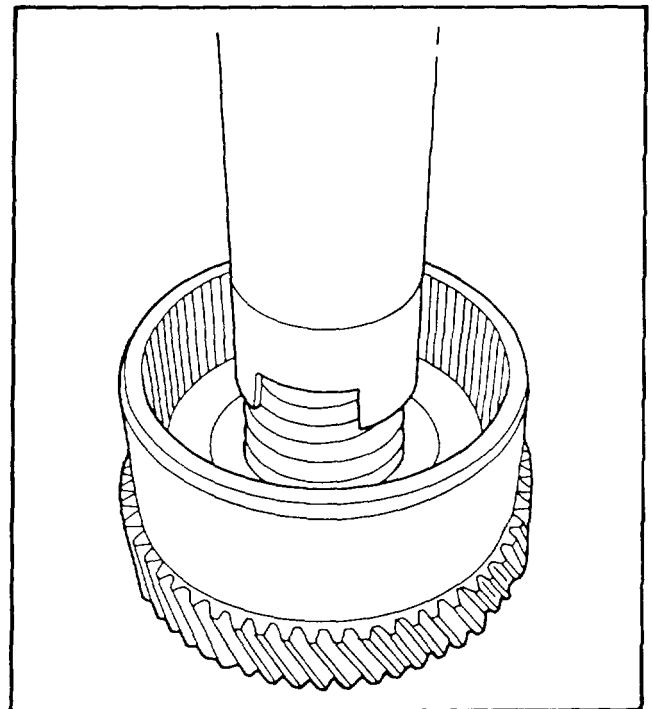


FIGURE I-20: Compressing clutch release spring.

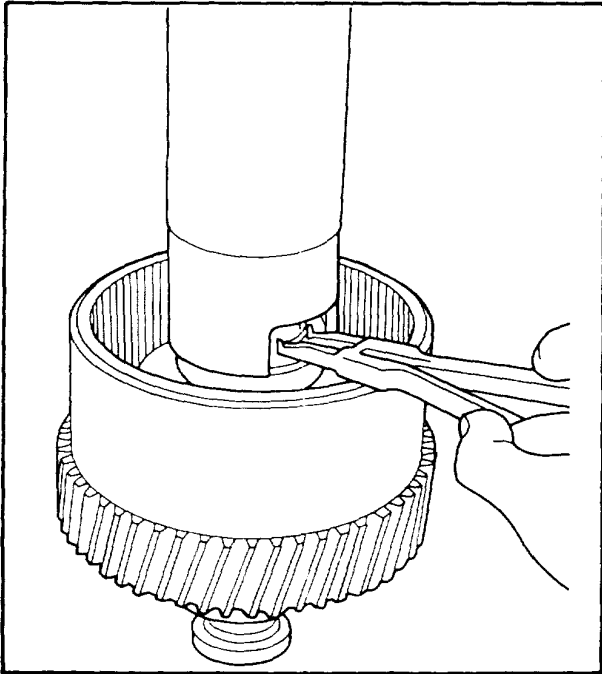


FIGURE I-21: Removing or installing clutch release spring retaining snap ring.

Remove the clutch return spring (Figure O-3 item 18) and spring retainer (Figure O-3 Item 19) (Figure I-22).

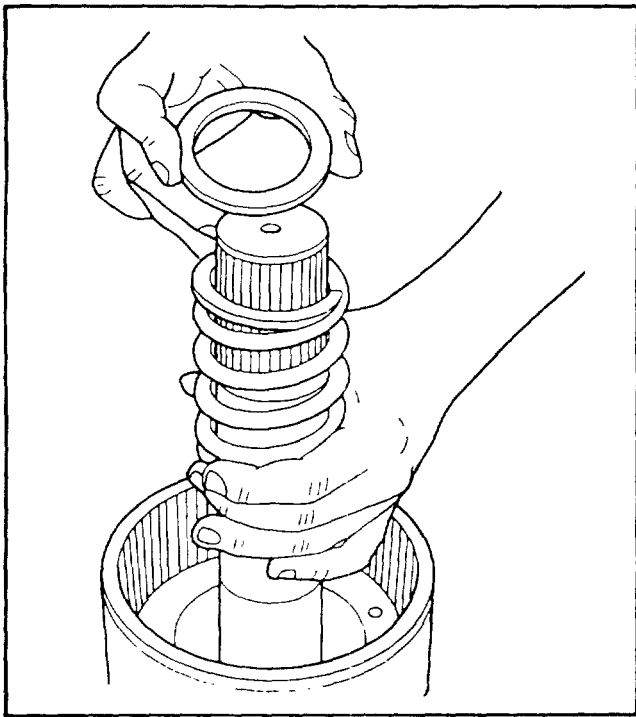


FIGURE I-22: Clutch release spring and retainer removed.

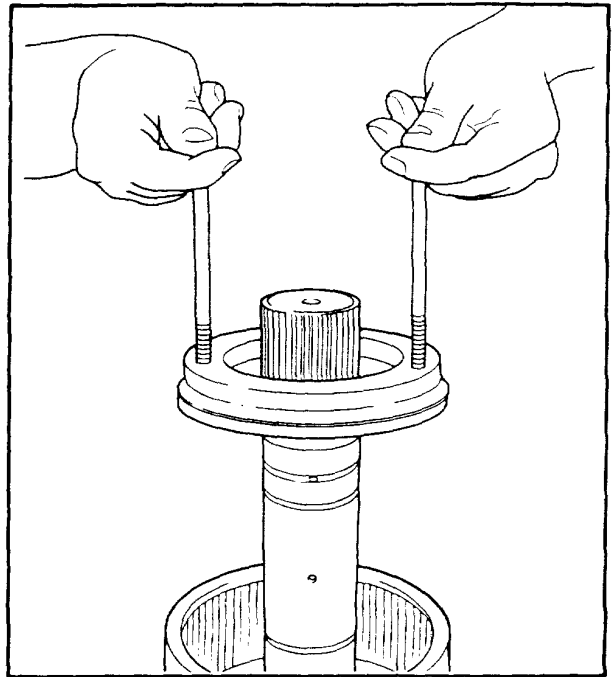


FIGURE I-23: Removing or installing clutch piston.

Remove the clutch piston (Figure O-3 Item 10) by installing two 5/16-18 UNC threaded rods into the holes provided and lifting out the piston (Figure I-23).

Remove the piston ring (Figure O-3 Item 9) from the outer periphery of the clutch piston (Figure O-3 Item 10). Remove the O-ring (Figure O-3 Item 12) from the inner diameter (Figure I-24).

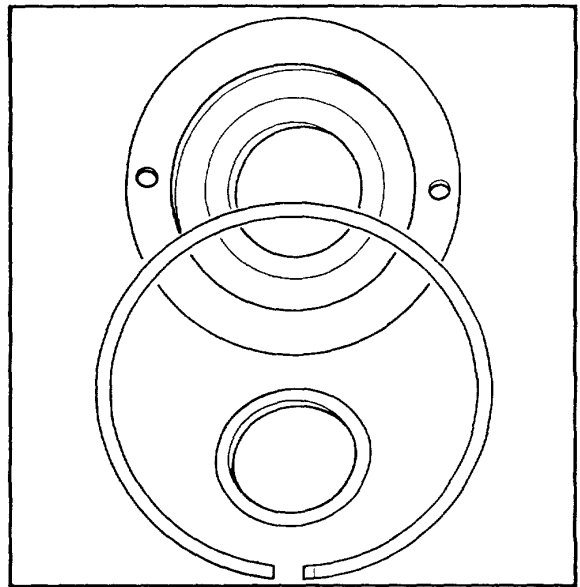


FIGURE I-24: Clutch piston, piston ring and O-ring removed.

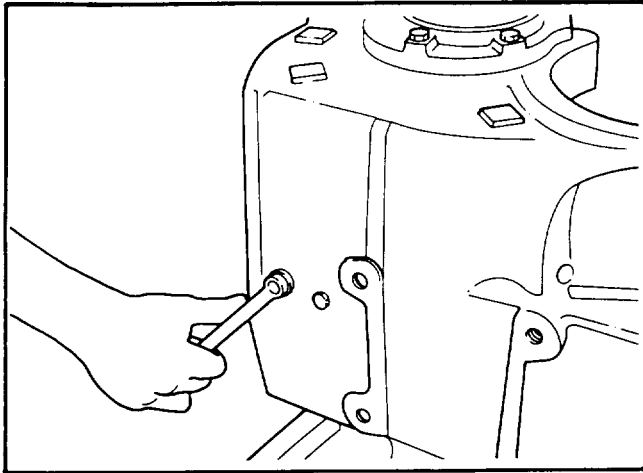


FIGURE I-25: Removing or installing capscrews securing gear pan.

CAUTION

Do not remove the rear tapered roller bearings (Figure O-3 Item 7) on forward clutch shaft (Figure O-3 Item 8) unless replacement of the parts is necessary. Close tolerances between inner bearing cone (Figure O-3 Item 7) and rear face of transfer gear (Figure O-3 Item 8) prohibits installation of bearing puller behind the inner cone.

If the bearing must be removed, split the bearing cage of front roller bearings (Figure O-3 Item 6) and remove the bearing rollers. Install a bearing puller on the bearing cone. Grip against the shoulder of the cone. Heat the bearing inner race by flash heating. Remove the inner race and cone.

CAUTION

Avoid prolonged heating to avoid affecting the heat treatment of the shaft assemblies.

CAUTION

Do not remove the driving transfer gear (Figure O-3 Item 8) from the input shaft. The shaft and gear are serviced as an assembly only.

REMOVAL OF THE OUTPUT GROUP OF PARTS

Remove the capscrews (Figure O-1 Item 9) securing the top cover (Figure O-1 Item 11) to the main housing (Figure O-1 Item 17).

Remove the capscrews (Figure O-1 Item 41) securing the gear pan (Figure O-1 Item 44) to the main housing (Figure O-1 Item 17) (Figure I-25). Remove the gear pan (Figure O-1 Item 44) (Figure I-26).

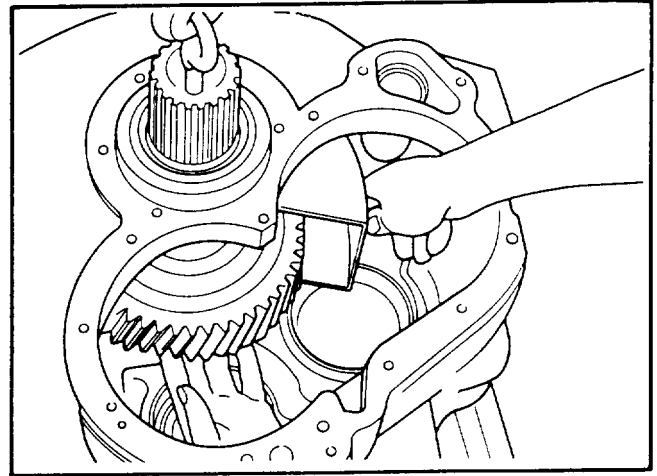


FIGURE I-26: Removing or installing gear pan or oil dam.

Remove the capscrews (Figure O-5 Item 7) securing the output seal carrier (Figure O-5 Item 8) to the main housing (Figure O-1 Item 17). Remove the seal carrier (Figure O-5 Item 8) (Figure I-27). Install a 1/2 UNC eyebolt at the end of the output shaft (Figure O-5 Item 12). Lift the output group so the removal of seal carrier (Figure O-5 Item 8), bearing (Figure O-5 Item 11), and output gear (Figure O-5 Item 13) can be achieved.

Lift the output group until the bearing cone (Figure O-5 Item 11) is free enough to enable an 'L' leg puller to be fitted and proceed with removal of bearing cone (Figure O-5 Item 11) (Figure I-28).

Lift the output shaft (Figure O-5 Item 12) as far as possible to tap out the expansion plug (Figure O-5 Item 17) closing the main housing (Figure O-1 Item 17) at the end of the output shaft (Figure O-5 Item 12). Use a long punch to ease out expansion plug (Figure I-29).

Install the press adapter TD-300427 or TD-300429 on the rear end of the output shaft (Figure O-5 Item 12) with two half washers. Localize the press adapter with the 3/8-16 screw. Seat this assembly under the hydraulic press (Figure I-30). Remove the snap ring (Figure O-5 Item 15) securing the rear bearing (Figure O-5 Item 14) at the end of the output shaft (Figure O-5 Item 12). Press the output shaft (Figure O-5 Item 12) out of the output gear (Figure O-5 Item 13). The pressure expected to separate the parts should be between 50 and 80 tons for ratios through 3.10:1, and between 80 and 100 tons for deeper ratios.

WARNING

Due to the force required, the press should be shielded as a precautionary measure.

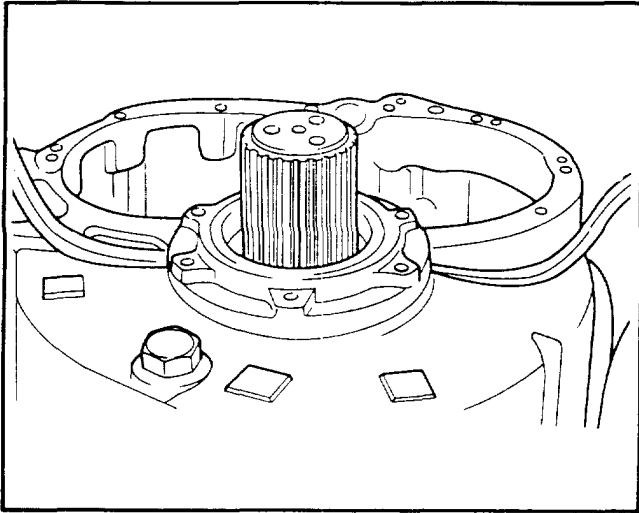


FIGURE I-27. Removing of seal carrier.

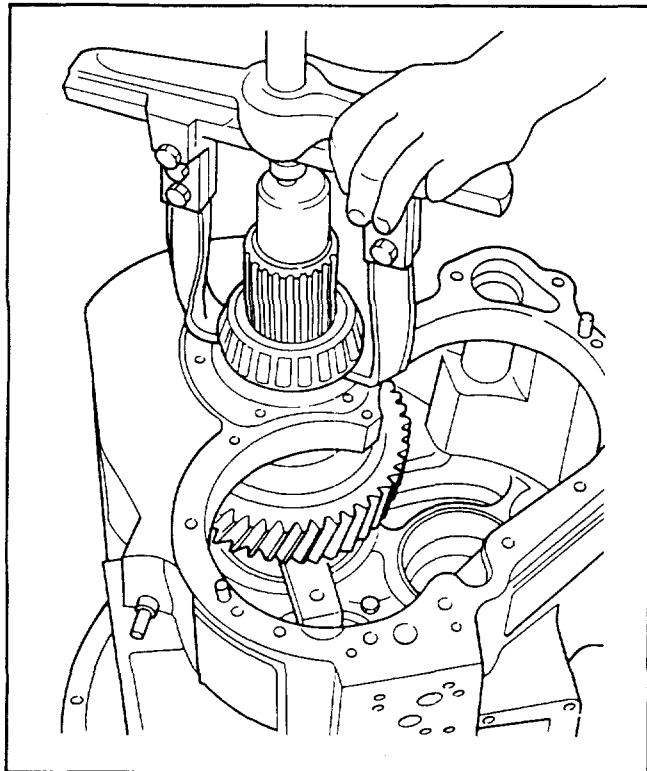


FIGURE I-28: Removing of rear bearing cone of output group.

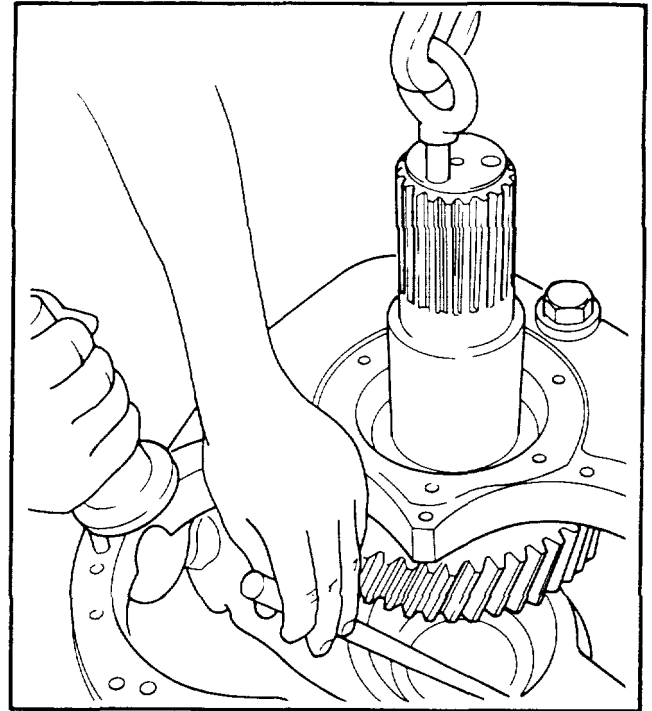


FIGURE I-29: Removing expansion plug.

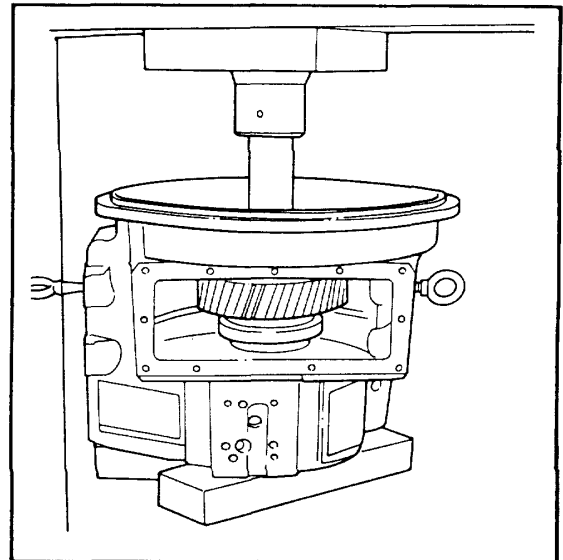


FIGURE I-30: Pressure output shaft from rear bearing inner race and gear.

NOTE

The steel ball (Figure O-2 Item 29) IS UNDER PRESSURE FROM THE SPRING (Figure O-2 Item 30). Care must be taken when removing the orifice plate (Figure O-2 Item 32) so that the steel ball is not lost.

DISASSEMBLY OF THE SELECTOR VALVE

Remove the capscrews (Figure O-2 Item 35) that secure the cover (Figure O-2 Item 34), gasket (Figure O-2 Item 33), orifice plate (Figure O-2 Item 32), and gasket (figure O-2 Item 31).

Remove the steel ball (Figure O-2 Item 29) and spring (Figure O-2 Item 30) from the valve body (Figure O-2 Item 19)

Remove the rate-of-rise piston (Figure O-2 Item 28), shims (Figure O-2 Item 17), inner spring (Figure O-2 Item 16), outer spring (Figure O-2 Item 15), and regulator piston (Figure O-2 Item 14) from the valve body (Figure O-2 Item 19).

Remove the capscrews (Figure O-2 Item 1) from shift lever (Figure O-2 Item 2). Remove shift lever from the valve stem (Figure O-2 Item 13).

Tap the rollpin (Figure O-2 Item 3) out of the stop collar (Figure O-2 Item 4). Remove the stop collar from the valve stem (Figure O-2 Item 13).

Remove the capscrews (Figure O-2 Item 5) from the cover (Figure O-2 Item 7).

Remove the cover (Figure O-2 Item 7), oil seal (Figure O-2 Item 6), O-ring (Figure O-2 Item 9), and gasket (Figure O-2 Item 8) from the valve stem (Figure O-2 Item 13).

Remove the thrust races (Figure O-2 Items 10, 12) and needle bearing (Figure O-2 Item 11) from the valve stem (Figure O-2 Item 13).

Remove the O-ring plug (Figure O-2 Item 24), O-ring (Figure O-2 Item 23) detent spring (Figure O-2 Items 21, 22), and detent (Figure O-2 Item 20) from the valve body (Figure O-2 Item 19).

Remove the valve stem (Figure O-2 Item 13) from the valve body (Figure O-2 Item 19).

CLEANING AND INSPECTION

J

GENERAL**Oil Seals**

Replace all oil seals.

Gaskets

Replace all gaskets.

Piston Rings

Replace all piston rings.

"O" Rings

Replace all "O" rings.

Seal Ring

Replace the seal ring.

Seal Washer

Replace the seal washer.

Capscrew Locks

Replace all capscrew locks.

CLEANING**Roller Bearings**

Use standard maintenance procedures to clean all roller bearings.

CAUTION

Never dry bearing with compressed air. Do not spin bearings while they are not lubricated. Oil bearings with SAE 10 engine oil immediately after cleaning. Be sure bearings are oiled before inspection.

Oil Pump Assembly

Use fresh cleaning agent to flush the oil pump assembly.

All Other Parts

Thoroughly clean all other parts with a suitable cleaning agent. Examine each part after cleaning to make certain all foreign matter (including the Loctite® plastic gasket material) has been removed. Be sure to remove the old Loctite® plastic gasket from the surfaces right down to the original metal. After cleaning, dry with compressed air. Lubricate all machined surfaces with clean oil.

Previously Sealed Joints

1. For previously sealed joints, scrape surfaces to remove old gasket material. Gel-type paint removers containing methylene chloride can be used to wipe off cured sealant.
2. Clean surfaces with 1,1,1 -trichloroethane to remove oil and grease residue.
3. Test for clean surfaces by applying a few drops of cool water to the surfaces. Parts are sufficiently clean if water covers the surface of the part in a film. If the water puddles or forms beads, use fresh solvent and reclean.

NOTE

The only Loctite® compounds approved for use with Detroit Diesel marine transmissions are part numbers 23990133 (6 mL) or 23990134 (50 mL) and 23509539 (10 mL).

NOTE

Do not use any abrasive material on selector valve parts as damage will result.

INSPECTION**Roller Bearings**

Use standard maintenance procedures to inspect all roller bearings.

Castings

Inspect all castings for cracks. Replace a cracked casting. Inspect all bearing bores and mounting faces for wear, grooves, scratches, etc. Remove burrs and scratches with a crocus cloth.

Inspect tapped holes for damaged threads. Chase damaged threads with a thread tap of the correct size. Replace all castings that cannot be repaired. The front and rear half housings are a matched set and cannot be replaced separately.

Splined Parts

Inspect all splined parts for worn, twisted, chipped, or burred splines. If possible, remove these defects with a soft stone. Replace a splined part that cannot be rectified.

Threaded Parts

Inspect all threaded parts for damaged threads. Repair damaged threads with a thread file or a fine three-cornered file. Replace a threaded part that cannot be rectified.

Snap Rings

Replace damaged or distorted snap rings.

Thrust Washers and Spacers

Inspect thrust washers for distortion, scores, burrs and wear. Rework or replace any defective thrust washers or spacers.

Bushings and Sleeves

Inspect bushings for size and out-of-roundness, scores, burrs, sharp edges, and evidence of overheating. Remove scores with a crocus cloth. If the bushing is out-of-round, deeply scored, or excessively worn, replace it.

Valve Seats

Inspect valve seats for burrs, nicks and scratches. If these defects cannot be removed with a crocus cloth, replace the part. Check to see that the valve is seating properly after reworking the valve seat.

Pressure and Temperature Gauge Assemblies

Inspect the pressure and temperature gauge assemblies for damage or inaccuracy. Replace a damaged or inaccurate gauge.

Driving Ring

Inspect the driving ring for damage or wear. Replace a damaged or worn ring.

Drive Spider

Inspect the drive spider for broken, cracked, or otherwise damaged lugs, spokes, or hub. Replace a damaged drive spider.

Rubber Blocks

Inspect rubber blocks for cracks, signs of melting, severe abrasion, or wear. If any signs of distress are visible, replace rubber blocks. Be sure to replace with identical part number blocks.

Torsional Coupling

Inspect the Torsional Coupling for cracks, tears, or other obvious damage to the rubber element. Inspect the tabs on hub for contact with "come home" (interference) tabs on the flywheel plate. If the rubber element shows signs of distress or the come home tabs have been contacted, replace the Torsional Coupling.

Oil Tubes

Inspect the oil tubes for damage. Replace a damaged oil tube. (Need special rolling tools.)

Flexible Hose

Inspect all flexible hoses for cracks, sponginess, or other damage. Replace a damaged hose.

Gear Teeth

Inspect all gear teeth for cleanliness and damage. Foreign particles tend to collect in the root of gear teeth. Clean thoroughly. Replace a gear that shows damage.

Orifices and Passages

It is very important that all orifices and passages be clean and clear. Use a small wire or a pipe stem cleaner to make certain the orifices and passages are clean and clear.

Mounting Brackets

Inspect the mounting brackets that support the marine transmission on the engine bedrails for cracks or other damage. Replace a damaged mounting bracket.

CAUTION

There is a possibility of clutch pack failure on initial start-up after rebuild, due to lack of lubrication until lube pressure builds up. All sintered metal clutch plates must be submerged in oil (use same oil as will be used in unit) for a minimum of one (1) hour prior to assembly. A longer soaking period would be even more beneficial. Covering the plates with oil from an oil can during assembly is NOT sufficient.

ASSEMBLY

K

SELECTOR VALVE

NOTE

If selector valve is equipped with optional trolling valve, refer to K-6.

Install the thrust races (Figure O-2 Items 10, 12) and thrust bearing (Figure O-2 Item 11) onto the valve stem (Figure O-2 Item 13).

Install the valve stem (Figure O-2 Item 13) with thrust parts (Figure O-2 Items 10, 11, 12) into the valve body (Figure O-2 Item 19).

Install O-ring (Figure O-2 Item 9) and oil seal (Figure O-2 Item 6) into the valve cover (Figure O-2 Item 7). Install gasket (Figure O-2 Item 8) and valve cover (Figure O-2 Item 7) with attached parts, onto the valve body (Figure O-2 Item 19). Secure with capscrews (Figure O-2 Item 5). Torque capscrews (Figure O-2 Item 5) to 22 +/- 2 lb.-ft.

Install the detent (Figure O-2 Item 20) into the threaded hole of the valve body (Figure O-2 Item 19). Make certain that the detent fits into the neutral recess of the valve stem (Figure O-2 Item 13).

Install springs (Figure O-2 Items 21, 22), O-ring (Figure O-2 Item 23) and plug (Figure O-2 Item 24) into threaded hole of valve body (Figure O-2 Item 19).

Install the stop collar (Figure O-2 Item 4). Align the drilled holes of the stop collar with the drilled hole of the valve stem (Figure O-2 Item 13).

Tap the rollpin (Figure O-2 Item 3) into the aligned holes of the stop collar (Figure O-2 Item 4) and valve stem (Figure O-2 Item 13).

With the valve stem (Figure O-2 Item 13) in the neutral position, secure the shift lever (Figure O-2 Item 2) onto the valve stem (Figure O-2 Item 13) with the capscrew (Figure O-2 Item 1) so that the shift lever is parallel with the mounting gasket side of the valve body (Figure O-2 Item 19).

Install the regulation piston (Figure O-2 Item 14), springs (Figure O-2 Items 15, 16), shims (Figure O-2 Item 17), and rate-of-rise piston (Figure O-2 Item 28) into the valve body (Figure O-2 Item 19).

Shims (Figure O-2 Item 17) determine the regulated clutch apply pressure. Additional shims increase pressure; likewise, fewer shims decrease clutch apply pressure.

Install spring (Figure O-2 Item 30) and steel ball (Figure O-2 Item 29) into the valve body (Figure O-2 Item 19). Install gasket (Figure O-2 Item 31), orifice plate (Figure O-2 Item 32), gasket (Figure O-2 Item 33), and cover (Figure O-2 Item 34). Secure with capscrews (Figure O-2 Item 35) torqued to 22 +/- 2 lb.-ft.

ASSEMBLY OF THE FORWARD CLUTCH

The following procedure describes the assembly of the forward clutch group of parts. The procedure for the reverse clutch group of parts is similar.

Heat the rear inner bearing race (Figure O-3 Item 7) in an oven at 275° F. for no longer than 30 minutes. Install the heated rear bearing inner race onto the input shaft (Figure O-3 Item 8).

Install a new piston ring (Figure O-3 Item 9) and O-ring (Figure O-3 Item 12) on the clutch piston (Figure O-3 Item 10).

Install the clutch piston (Figure O-3 Item 10) aligning the two rollpins (Figure O-3 Item 11) in the driving transfer gear (Figure O-3 Item 24) with the holes provided in the clutch piston.

Install the clutch return spring (Figure O-3 Item 18) and spring retainer (Figure O-3 Item 19).

Compress the return spring (Figure O-3 Item 18) using a hydraulic press and special tool TD-300422. Install the snap ring (Figure O-3 Item 20) into the groove provided on the input shaft (Figure O-3 Item 8).

Install the one side sintered plate (Figure O-3 Item 15) with the sintered side up. Alternate steel (Figure O-3 Item 14) and sintered plates (Figure O-3 Item 13) in the clutch assembly. The first installed plate is to be steel. Install the remaining one side sintered plate (Figure O-3 Item 15) with the sintered side down.

Install the clutch backplate (Figure O-3 Item 16) and snap ring (Figure O-3 Item 17).

Install the rear thrust bearings onto the input shaft (Figure O-3 Item 8). Install thrust race (Figure O-3 Item 21), thrust bearing (Figure O-3 Item 22), and thrust race (Figure O-3 Item 23) in that order.

Pre-align the splined teeth on steel clutch plates (Figure O-3 Item 14) and install the forward pinion (Figure O-3 Item 24) onto the input shaft (Figure O-3 Item 8). Align the steel clutch plates with the splines on the pinion.

Install the front thrust bearings onto the forward pinion. Install thrust race (Figure O-3 Item 25), thrust bearing (Figure O-3 Item 26), and thrust race (Figure O-3 Item 27) in that order.

Install the snap ring (Figure O-3 Item 28) into the groove provided at the end of the shaft (Figure O-3 Item 8).

Install the bearing outer race (Figure O-3 Item 31) onto the splined end of the shaft (Figure O-3 Item 8). Turn the carrier so that it will be localized by the splines. This is done to ease installation into the main housing (Figure O-1 Item 17).

ASSEMBLY OF THE OUTPUT GROUP OF PARTS

Degrease the surface of the bore of the output gear (Figure O-5 Item 13) and the mating surface of the output shaft (Figure O-5 Item 12) with 1,1,1 trichloroethane. Both surfaces must be absolutely clean and free from grease and other contaminants. Wipe with lint-free towel.

NOTE

Do not heat the output gear nor chill the shaft. Both parts must be at room temperature during assembly.

- i) Measure and record the distance from the rear of the shaft (Figure O-3 Item 12) to the shoulder on the shaft at the small end of the taper (Distance A in Figure K-1).
- ii) Place the output gear (Figure O-5 Item 13) on the shaft (Figure O-5 Item 12) and seat it using 100 to 200 lbs. maximum force.
- iii) Measure and record the distance from the rear of the shaft (Figure O-5 Item 12) to the rear face of the gear (Figure O-5 Item 13) (Distance B in Figure K-1).

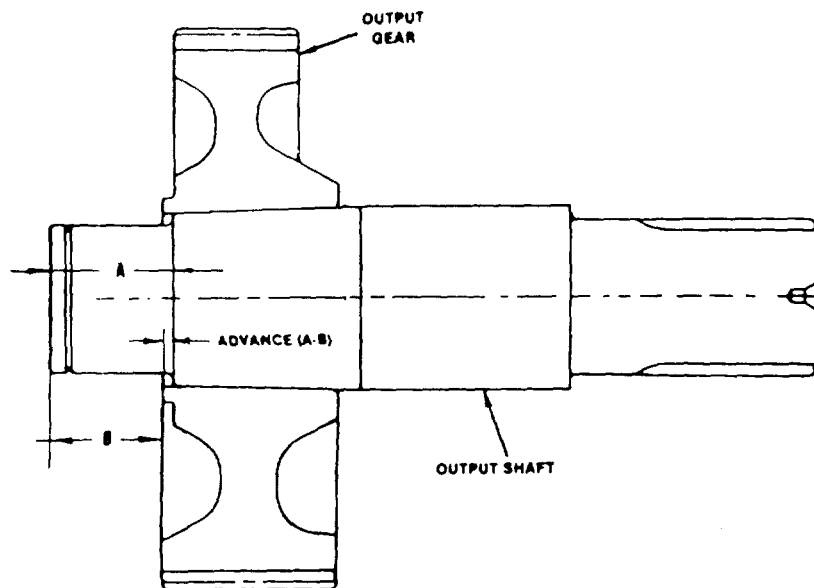


FIGURE K-1: Determining output gear advance.

Subtract the distance (B) measured in step iii) from the distance measured in step i). The result is the advance of the gear. This measurement must be 0.080-0.97 inch for ratios 1.1 2:1 through 3.10:1 and 0.102-0.121 inch for deeper ratios.

Install the main housing (Figure O-1 Item 17) on suitable blocks under the hydraulic press with the outer race of the bearing installed (Figure O-5 Item 10).

Having placed press adapter TD 300427 on the press table through the front bearing bore, install the inner race of front bearing (Figure O-5 Item 14) and the output gear (Figure O-5 Item 13) on to it.

Install the shaft (Figure O-5 Item 12) into the gear (Figure O-5 Item 13) and press to advance it until the inner bearing (Figure O-5 Item 14) seats on its shoulder (Figure K-2).

NOTE

The force required to advance the gear on shaft should be 50-70 tons for ratios through 3.10:1 and 79-109 tons for deeper ratios. The press should be shielded as a precaution.

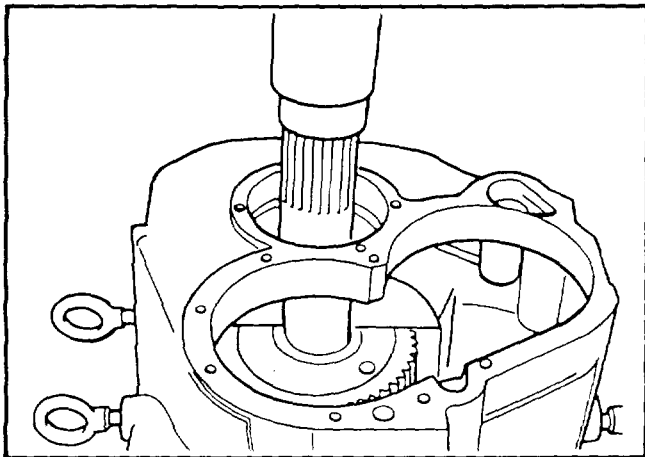


FIGURE K-2: Output shaft and gear installation.

Install the gear pan (Figure O-1 Item 44) onto the output gear. Tilt the output gear to ease entry. Secure the gear pan to the main housing (Figure O-1 Item 17) with the capscrews (Figure O-1 Item 41) and their sealing washers (Figure O-1 Item 40).

Install the rear inner bearing (Figure O-5 Item 11) and seat it against its shoulder with the hydraulic press using 10 tons force and press adapter TD 300429.

Install the outer race so bearing (Figure O-5 Item 10) and the bearing carrier (Figure O-5 Item 8) into the main housing bore with a theoretical shim pack (Figure O-5 Item 9) of 0.060 inch. Secure the bearing carrier with capscrews (Figure O-5 Item 7) onto the main housing. Torque to 38 lb.-ft. (Figure K-3).

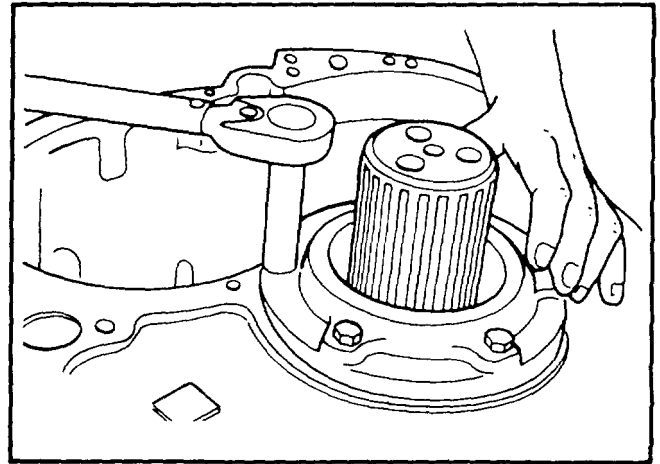


FIGURE K-3: Carrier seal, bearing retainer installation.

Remove the main housing (Figure O-1 Item 17) from the press table and install the external snap ring (Figure O-5 Item 15) at the end of the shaft. Install the expansion plug (Figure O-5 Item 17) with Loctite® 23990133 or 23990134 sealant in the bore shoulder. Press the middle of the plug to expand it.

Perform a runout check of the gear face. 0.005 T.I.R. is a maximum acceptable runout (Figure K-4). Should runout exceed the maximum, the gear should be removed from the shaft and the assembly procedure restarted at step i).

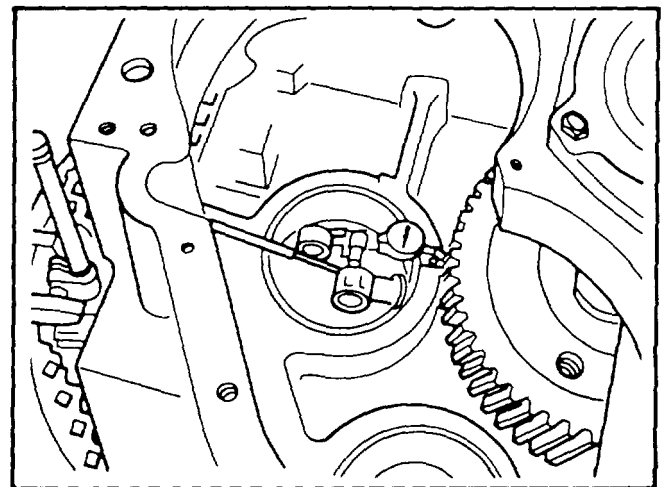


FIGURE K-4: Runout check.

ASSEMBLY OF THE MAIN HOUSING GROUP OF PARTS

Install bearing outer races (Figure O-3 Item 31) (Figure O-4 Item 34) and press them against the shoulders provided in the housing (Figure O-1 Item 17).

Install a new oil seal (Figure O-3 Item 32) with the lip open toward the oil.

INTERNAL PARTS

Install forward and reverse clutch groups by aid of special lifting tool TD-300426.

Clean surfaces of bearing carrier (Figure O-1 Item 31) and main housing (Figure O-1 Item 17) with 1,1,1 trichloroethane to remove oil and grease residue.

Test for clean surfaces by applying a few drops of cool water to the surfaces. Parts are sufficiently clean if water covers the surface in a film. If the water puddles or forms beads, use fresh solvent and re-clean.

Use primer P/N 23509685 on both mating surfaces. Allow the primer to dry. This usually takes three to four minutes. Keep surfaces clean and free of oil and grease from this point on.

Apply a 1/16 inch bead of Loctite® P/N 23990133 or 23990134 to one surface on the outside of the bolt holes of bearing carrier (Figure O-1 Item 31). Be certain that narrow overlap of areas are covered. See Figure K-5.

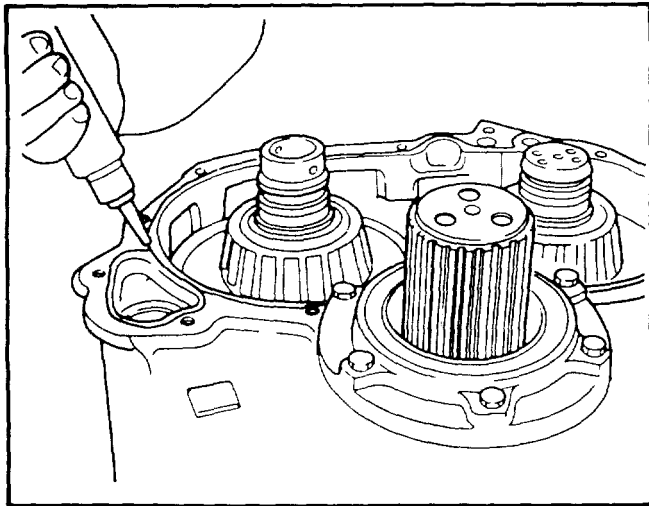


FIGURE K-5: Sealant application on main housing mating face.

Install the bearing carrier (Figure O-1 Item 31) and bearing outer races (Figure O-3 Item 6) (Figure O-4 Item 6) over the main housing aligning the two dowel pins (Figure O-1 Item 18) with their holes as well as the outer race of the bearings.

TAPERED BEARING ADJUSTMENT

Install a theoretical 0.020 inches shim pack (Figure O-3 Item 4) (Figure O-4 Item 3) into the bearing bores, with the outer races (Figure O-3 Item 6) (Figure O-4 Item 6) and their spacers (Figure O-3 Item 5) (Figure O-4 Item 5).

NOTE

Do not apply LOCTITE® on the manifold mating surfaces at this time.

Install the manifold (Figure O-1 Item 29) over the bearing carrier (Figure O-1 Item 31) and secure with all screws (Figure O-1 Items 23,24). Torque to 40 ± 3 lb-ft.

Install the endplay fixture to TD-300423 at the front end of the forward shaft (Figure O-3 Item 8) and attach a dial indicator securely onto the housing so that the indicator finger rests on the end of the forward clutch shaft (Figure K-6).

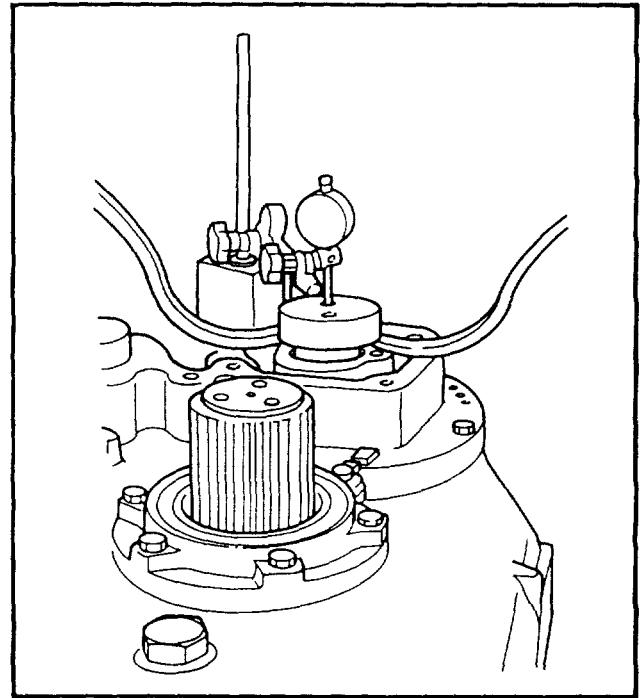


FIGURE K-6: End play adjustment of clutch group.

Apply to the shaft a downward load of at least its own weight. Maintain this load while rotating the shaft several times, and set the indicator to zero.

Apply an upward load of at least twice the weight of shaft and rotate the shaft several times. The indicator reading is the endplay. It should read 0.002 (minimum) to 0.006 inches (maximum).

Repeat the above procedures with the reverse clutch shaft special tool TD-300424.

Remove the manifold (Figure O-1 Item 29) and add shims (Figure O-3 Item 4) (Figure O-4 Item 3), as needed, to set endplay to required range (0.002-0.006 inches).

Install the pump drive adapter (Figure O-4 Item 8) with drive pin (Figure O-4 Item 11) and the wear sleeve (Figure O-4 Item 9) with special tool T-17880.

Clean mating surfaces of bearing carrier (Figure O-1 Item 31) and manifold assembly (Figure O-1 Item 29) with 1,1,1 trichloroethane to remove oil and grease residue.

Test for clean surfaces by applying a few drops of cool water to the surfaces. Parts are sufficiently clean if water covers the surface of the parts in a film. If the water puddles or forms beads, use fresh solvent and re-clean.

Use LOCTITE® primer p/n 23509685 on both mating surfaces. Allow the primer to dry, usually 3-4 minutes. Keep surfaces free of oil and grease from this point. (Figure K-8).

Recheck endplay as described previously. Adjust shim pack thickness as required. Remove forward clutch shim pack.

Apply LOCTITE® p/n 23509539 to entire inner diameter surface of shim pack. Use sufficient quantity to wick between shims. Wipe off excess. (Figure K-8).

Replace forward clutch shim pack. Repeat above procedure with reverse clutch shim pack.

Check the endplay on the output shaft as described below (Figure K-7).

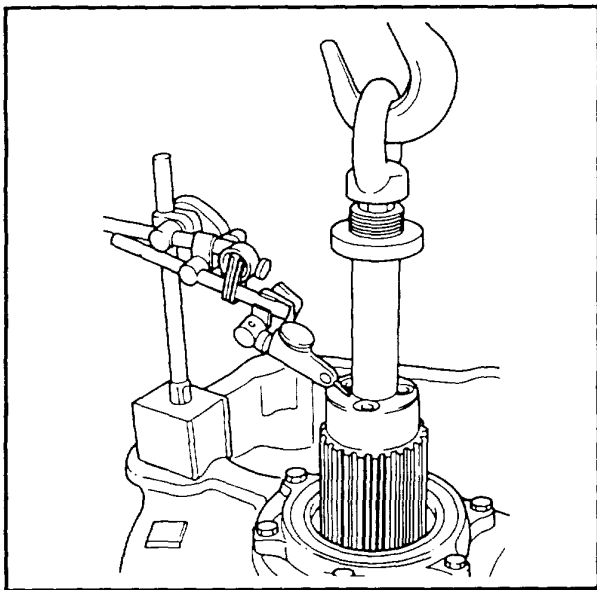


FIGURE K-7: End play adjustment of output shaft.

Attach the endplay adjustment fixture TD-300428 to the end of the output shaft.

Attach a dial indicator securely to the housing with the indicator finger resting on the end of the adjustment fixture.

Apply to the shaft a downward load of at least its own weight.

The indicator reading (endplay) should read from 0.002 to 0.006 inches.

Remove the bearing carrier (Figure O-5 Item 8) and add shims (Figure O-5 Item 9), as required, to achieve 0.002 to 0.006 inches endplay.

Clean mating surfaces of bearing carrier (Figure O-5 Item 8) and housing assembly (Figure O-1 Item 17) with 1,1,1 trichloroethane to remove oil and grease residue.

Test for clean surfaces by applying a few drops of cool water to the surfaces. Parts are sufficiently clean if water covers the surface of the parts in a film. If the water puddles or forms beads, use fresh solvent and re-clean.

Use LOCTITE® primer p/n 23509685 on both mating surfaces. Allow the primer to dry, usually 3-4 minutes. Keep surfaces free of oil and grease from this point. (Figure K-9).

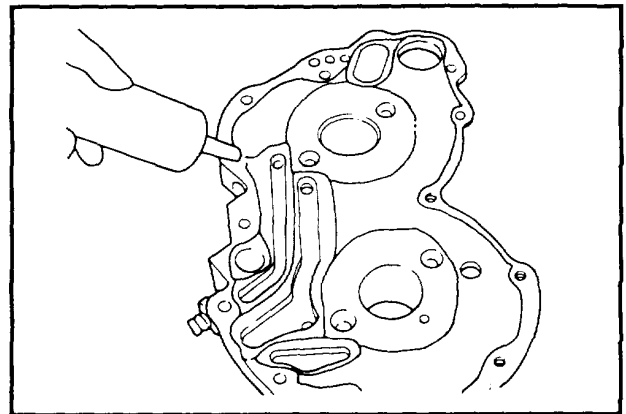


FIGURE K-8: Sealant application on manifold.

Recheck endplay as described previously. Adjust shim pack thickness as required. Remove output shaft shim pack.

Apply LOCTITE® p/n 23509539 to entire inner diameter surface of shim pack. Use sufficient quantity to wick between shims. Wipe off excess. (Figure K-8).

Replace output shaft shim pack.

Refer to Section G for oil seal and output flange assembly procedures.

FINAL ASSEMBLY

Align the mark previously made on the hydraulic pump flange (Figure O-1 Item 2) with the corresponding mark on the manifold (Figure O-1 Item 29). Install the gasket (Figure O-1 Item 3) and hydraulic pump (Figure O-1 Item 2). Secure with four capscrews (Figure O-1 Item 1) torqued to 65 ± 5 lb.-ft.

Clean the surfaces of the core plug (Figure O-1 Item 28) and mating bore in manifold (Figure O-1 Item 29) to remove oil and grease residue. Use 1,1,1 trichloroethane.

Apply a 1/16 inch bead of LOCTITE® p/n 23990133 or 23990134 on the outside of plug (Figure O-1 Item 28) and press into bore.

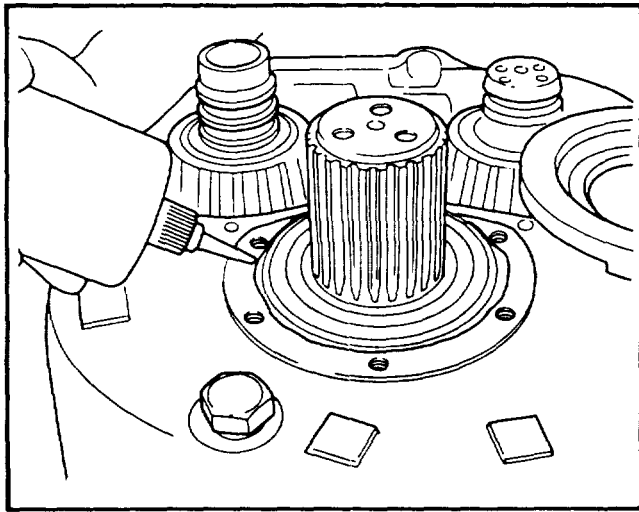


FIGURE K-9: Sealant application on carrier bearing.

Secure the plug (Figure O-1 Item 28) with retainer plate (Figure O-1 Item 27) and two capscrews (Figure O-1 Item 25) torqued to 65 lb.-ft.

Install the filter screen (Figure O-1 Item 36) with plug (Figure O-1 Item 35) and "O" ring (Figure O-1 Item 32). Secure clamp plate (Figure O-1 Item 34) with capscrew (Figure O-1 Item 32). Torque to 40 ± 3 lb.-ft.

Clean top cover (Figure O-1 Item 11) and housing assembly (Figure O-1 Item 17) with 1,1,1 trichloroethane to remove oil and grease residue.

Apply 1/16 bead of LOCTITE® p/n 23990133 or 23990134 to one surface on the outside of bolt holes.

Install the top cover (Figure O-1 Item 11) with capscrews (Figure O-1 Item 9). Torque to 38 lb.-ft.

Install the selector valve (Figure O-1 Item 4) with capscrews (Figure O-1 Item 51 and gasket (Figure O-1 Item 7). Torque to 38 lb.-ft.

Install the oil gauge tube assembly (Figure O-1 Item 42).

ASSEMBLY OF SELECTOR WITH TROLLING VALVE OPTION

Install oil seal (Figure O-7 Items 17, 26) into each end of the trolling cover assembly (Figure O-7 Item 14).

Install one O-ring (Figure O-7 Item 16) onto the trolling valve shaft (Figure O-7 Item 15) (Figure K-10).

Push the trolling valve shaft (Figure O-7 Item 15), O-ring end last through the trolling cover assembly (Figure O-7 Item 14) and cam (Figure O-7 Item 24) just far enough that the groove for the other O-ring (Figure O-7 Item 16) is exposed.

NOTE

Make sure the cam and shaft are installed correctly. Otherwise, the trolling valve will not work properly. That is correct trolling pressure will not be achieved.

Install the other O-ring (Figure O-7 Item 16) onto the trolling valve shaft (Figure O-7 Item 15).

Turn the trolling valve shaft (Figure O-7 Item 15) in the trolling valve cover assembly (Figure O-7 Item 14) until the drilled rollpin hole of the shaft (Figure O-7 Item 15) is lined up with the drilled hole of the cam (Figure O-7 Item 25).

Install the rollpin (Figure O-7 Item 25) through the lined up holes of the trolling valve shaft (Figure O-7 Item 15) and cam (Figure O-7 Item 24). See Figure K-10.

NOTE

End of the rollpin must not protrude above the cam surface.

Install the trolling valve shift lever (Figure O-7 Item 28) onto the trolling valve shaft (Figure O-7 Item 15) and secure with hex nut (Figure O-7 Item 27). The valve shift lever may be installed on either end of the trolling valve shaft.

Install the detent (Figure O-7 Item 9), detent spring (Figure O-7 Item 8) and O-ring plug (Figure O-7 Item 6) with O-ring (Figure O-7 Item 7) into the threaded hole of the trolling cover assembly (Figure O-7 Item 14).

Move the trolling shift lever (Figure O-7 Item 28) so the cam (Figure O-7 Item 24) is in the detent position.

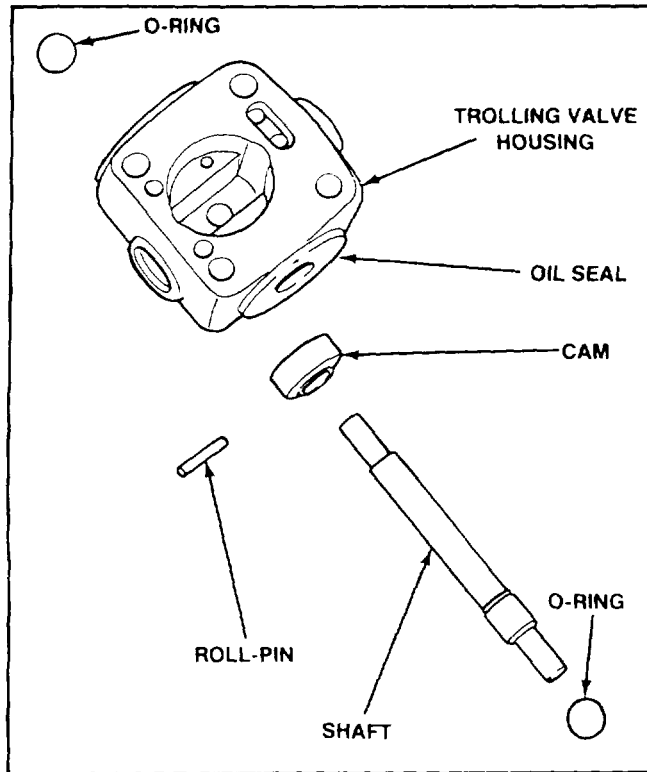


FIGURE K-10: Trolling valve.

Screw the dog-point setscrew (Figure O-7 Item 4) into the threaded hole of the trolling valve cover assembly until it comes into contact with the cam (Figure O-7 Item 24).

Back the dog-point setscrew (Figure O-7 Item 4) off the cam by 1/4 turn and lock into place by screwing the lock screw (Figure O-7 Item 3) into the threaded hole against the dog-point setscrew (Figure O-7 Item 4).

NOTE

When installing the lock screw, use an oil free 3/16 inch alien wrench with tape wrapped so that the dog-point setscrew is not accidentally threaded back toward the cam. See Figure K-11.

Install O-ring plug (Figure O-7 Item 1) with the O-ring (Figure O-7 Item 2) into the threaded hole of the trolling valve cover assembly.

Rotate trolling valve shaft (Figure O-7 Item 15) so that the hole in the shaft lines up with the hole in the trolling cover assembly (Figure O-7 Item 14).

Lock the cam setscrew (Figure O-7 Item 13) in place by screwing the lock screw (Figure O-7 Item 12) into the threaded hole of the valve cover assembly until it comes into contact with the cam setscrew (Figure O-7 Item 13).

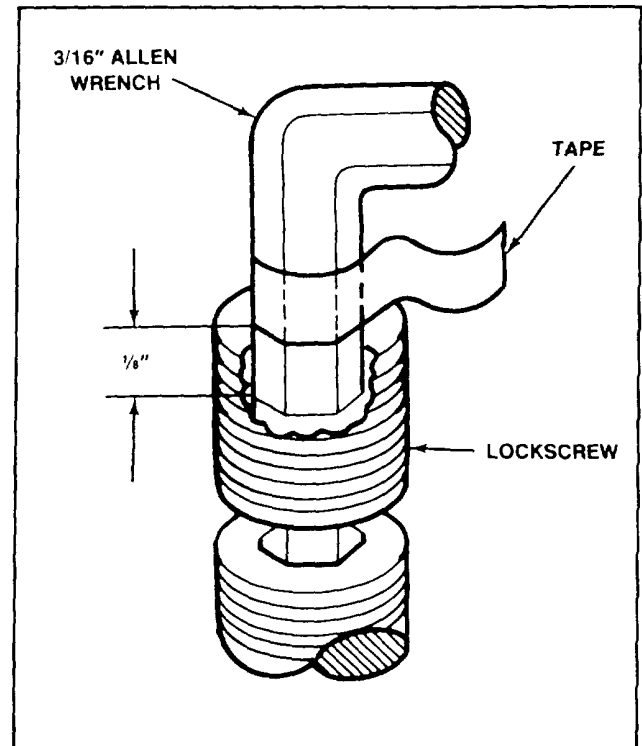


FIGURE K-11: Special Allen wrench application.

NOTE

When installing the lock screw, use an oil free 3/16 inch alien wrench with tape wrapped so that the cam setscrew is not accidentally threaded back toward the cam. See Figure K-11.

Install O-ring plug (Figure O-7 Item 10) with the O-ring (Figure O-7 Item 11) into the threaded hole of the trolling valve cover assembly.

Install the thrust race (Figure O-2 Item 10), thrust bearing (Figure O-2 Item 11), and thrust race (Figure O-2 Item 12) in that order, onto the valve stem (Figure O-2 Item 13).

Install the valve stem (Figure O-2 Item 13) with the attached parts, into the valve body (Figure O-2 Item 19).

Install the O-ring (Figure O-2 Item 9) and oil seal (Figure O-2 Item 6) into the valve cover (Figure O-2 Item 7).

Install the gasket (Figure O-2 Item 8) and valve cover (Figure O-2 Item 7) and attached parts onto the valve body (Figure O-2 Item 19) and secure with the four capscrews (Figure O-2 Item 5). Torque to 22 +/- 2 lb.-ft.

install the detent (Figure O-2 Item 20) into the threaded hole of the valve body (Figure O-2 Item 19). Make certain that the detent fits into the neutral recess of the valve stem (Figure O-2 Item 13).

Install spring (Figure O-2 Item 19) and O-ring (Figure O-2 Item 23) and O-ring plug (Figure O-2 Item 24) into the threaded hole of the valve body.

Install the stop collar (Figure O-2 Item 4) aligning the drilled holes of the stop collar with the drilled hole of the valve stem (Figure O-2 Item 13).

Tap rollpin (Figure O-2 Item 3) into the aligned holes of the stop collar (Figure O-2 Item 4) and valve stem (Figure O-2 Item 13).

Install the high pressure regulating piston (Figure O-2 Item 14), outer spring (Figure O-7 Item 21), middle spring (Figure O-7 Item 22), inner spring (Figure O-7 Item 23), shims (Figure O-7 Item 20), and rate-of-rise piston

(Figure O-7 Item 18) with piston rollpin (Figure O-2 Item 19) into the valve body.

Install spring (Figure O-2 Item 30) and steel ball (Figure O-2 Item 29) into the valve body.

Install gasket (Figure O-2 Item 31), orifice plate (Figure O-2 Item 32), gasket (Figure O-2 Item 33), and trolling cover (Figure O-2 Item 34) with the attached parts, onto the valve body. Secure with the four capscrews (Figure O-2 Item 351). Torque to 22 +/-2 lb.-ft.

Adjust the trolling valve shaft lever (Figure O-7 Item 28) to the desired position and secure onto the valve stem (Figure O-7 Item 15) with capscrew (Figure O-7 Item 29).

INSTALLATION

L

PRIOR TO INSTALLATION

General

The marine transmission flange and pilot, and the engine flywheel and flywheel housing must be checked for trueness. Make certain the engine flywheel and flywheel housing are clean prior to making the tests. Make sure the crankshaft is moved to zero end play while making all face checks.

Checking Marine Transmission Flange

Bolt a dial indicator graduated in thousandths inches to the drive spider or Torsional Coupling of the marine transmission so that the indicator is perpendicular to the face of the marine transmission housing, and the indicator stem is riding on the face of the flange. Rotate the drive spider and note the face runout of the marine transmission flange. The face runout must not exceed 0.010 inch maximum total indicator reading for the SAE No. 2 flange, or a 0.012 inch maximum total indicator reading for the SAE No. 1 flange.

Checking Marine Transmission Pilot Ring

With the indicator mounted as in the paragraph above, adjust the indicator stem so that it will ride on the pilot surface of the flange. Rotate the drive spider and note the pilot surface runout of the flange. The pilot surface runout must not exceed 0.008 inch for the SAE No. 2 flange, or 0.008 inch for the SAE No. 1 flange. This applies to a continuous 270 degree arc if the balance of the pilot surface is negative in reading; otherwise, it means all 360 degrees.

Checking Face of Engine Flywheel Housing

Bolt a dial indicator graduated in thousandths inches to the engine flywheel so that the indicator is perpendicular to the face of the engine flywheel housing, and the indicator stem is riding on the face of the flange (Fig. L-1). Rotate the engine flywheel and note the face deviation of the engine flywheel housing flange. The face deviation must not exceed 0.013-inch maximum total indicator reading.

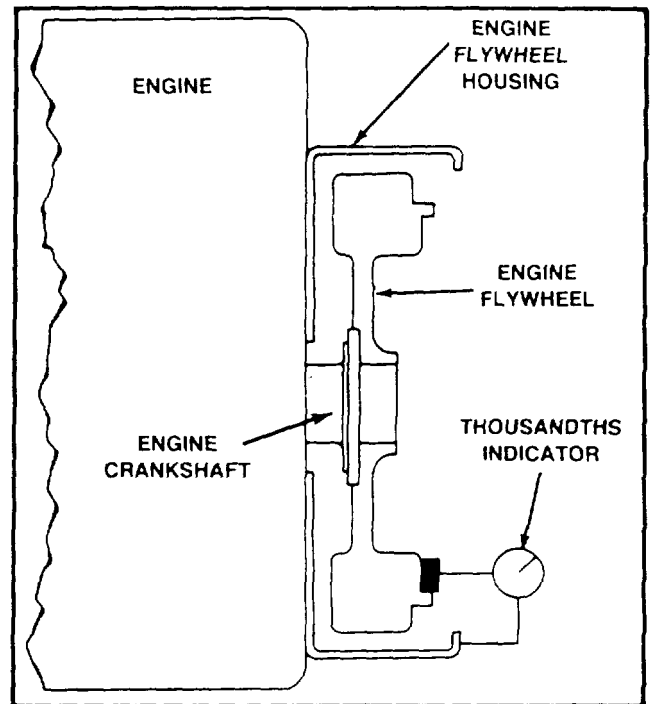


FIGURE L-1: Checking the Face of the Engine Flywheel Housing

Checking Bore of Engine Flywheel Housing

With the indicator mounted as in the paragraph above, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing (Fig. L-2). Rotate the engine flywheel and note the eccentricity of the engine flywheel housing bore. The bore eccentricity must not exceed 0.03-inch maximum total indicator reading.

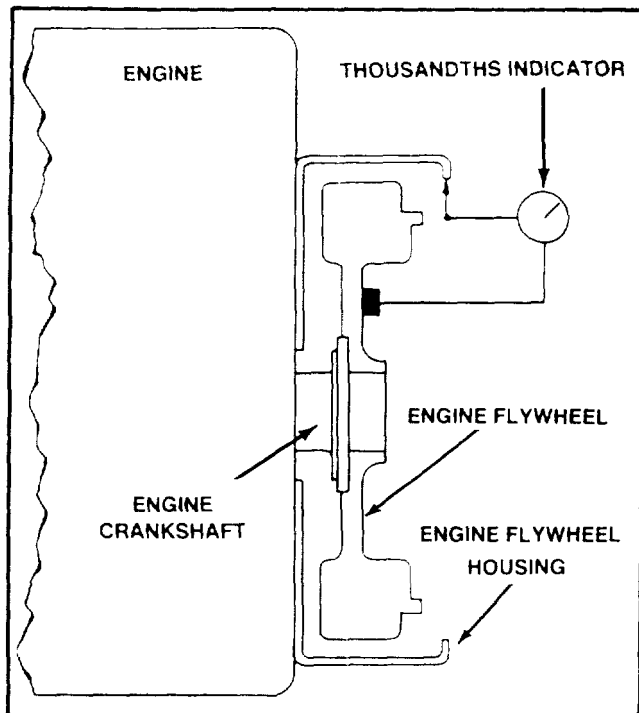


FIGURE L-2: Checking the Bore of the Engine Flywheel Housing

Checking Driving Ring Surface of Engine Flywheel

Bolt a dial indicator graduated in thousandths inches to the engine flywheel housing so that the indicator is perpendicular to the engine flywheel, and the indicator stem is riding on the inner face of the flywheel (Fig. L-3). The variation of the face runout of the surface to which the driving ring is bolted should not exceed 0.0005-inch maximum total indicator reading per inch of diameter.

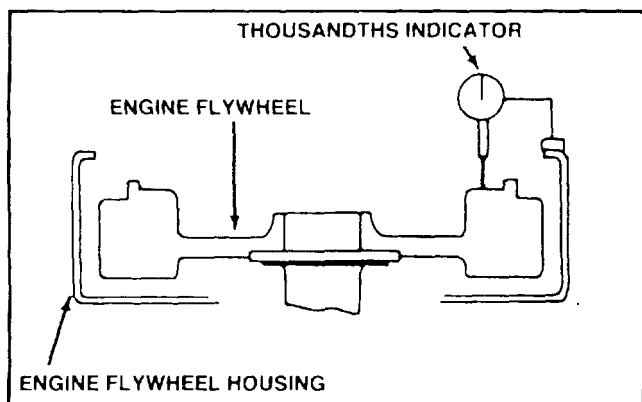


FIGURE L-3: Checking the Driving Ring Surface of the Engine Flywheel Housing

Checking Driving Ring Pilot Bore of Engine Flywheel

With the indicator mounted as in the paragraph above, adjust the indicator stem so that it will ride on the driving

ring pilot bore of the engine flywheel (Fig. L-4). The driving ring pilot bore eccentricity of the engine flywheel should not exceed 0.005-inch maximum total indicator reading.

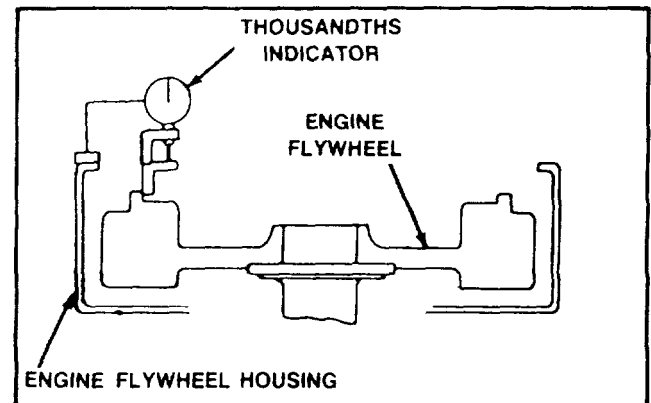


FIGURE L-4: Checking the Driving Ring Pilot Bore of the Engine Flywheel Housing

INSTALLATION

(See Section M, Alignment, for alignment of propeller shaft mating flange.)

General

The alignment of the marine transmission with the engine is an extremely important factor in obtaining lengthy, trouble-free performance from the marine transmission. An extra few minutes of time for an accurate and proper installation will be returned many times in avoiding unnecessary future downtime.

Alignment

Install the mounting brackets on the side mounting pads of the marine transmission. Install the driving ring or Torsional Coupling on the engine flywheel with the fasteners previously removed. Bolt an indicator to the engine block and set the indicator stem on the engine flywheel housing. Set the indicator gauge at zero (0). Lift the marine transmission with a hoist, or other suitable means, and place the unit in position against the engine flywheel housing. Guide the rubber blocks on the drive spider into the driving ring or splined shaft into Torsional Coupling. Secure the flange of the marine transmission housing to the engine flywheel housing with twelve (7/16-14 x 13/16) hex-head capscrews. Tighten the capscrews to 55 lb.-ft. torque. Use a feeler gauge between each mounting bracket and engine bedrail. Add shims between the brackets and bedrails to equal the feeler gauge readings. Carefully release the lifting force

on the marine transmission. The indicator gauge must remain steady at the zero mark. Torque bed bolts to proper rating. If the reading moves from zero, lift the marine transmission and insert additional shims. Continue this procedure until the marine transmission is completely at rest on the bedrails and the gauge maintains a steady zero reading. After obtaining the correct zero reading, secure the mounting brackets to the engine bedrails. Before securing the mounting brackets to the engine bedrails, the propeller shaft should be checked for alignment. See text on alignment, beginning with Section (M).

Output Flange Connection

Slide the propeller shaft and the companion flange forward against the output flange. Align the scribed

marks on the companion flange and the output flange. Secure the flanges together with the bolts and nuts previously removed.

Connecting Linkage

Connect all linkage and lines previously disconnected from the marine transmission.

Hydraulic System

Fill the hydraulic system with the proper type, weight, and amount of oil as specified in Table 1.

ALIGNMENT

M

ALIGNMENT

Proper alignment of an engine and marine transmission is critical ... both during the initial installation and at frequent intervals during the life of the boat. It is quite common for a boat to change its form under various loads and with age. A bend is actually formed in the keel which changes the original engine and shaft alignment. The following steps may be taken to ensure proper marine transmission alignment.

PROPELLER SHAFT INSTALLATION

A wire is run through the shaft log and secured to a brace near the engine bed, giving the wire a position equivalent to the shaft centerline.

The stern bearing and stuffing box are installed and bolted into position with the wiring passing through each in the exact center of the bore. With the bearing and stuffing box in place, the wire is then removed.

The propeller shaft is then installed in its proper position.

If an intermediate shaft is used, it is blocked into position and its coupling is aligned with the propeller shaft coupling (see the following section-"Engine and Marine Transmission Alignment"). If there is an intermediate bearing in the line, this is installed and positioned with shims during the alignment process.

If a light shaft is used without an intermediate bearing, the shaft must be centered and supported to take out the droop while the flange coupling alignment is being made.

ENGINE AND MARINE TRANSMISSION ALIGNMENT
TO PROPELLER SHAFT

It is important to align the engine and gear only when the boat is afloat and *not* in dry-dock.

During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when the boat is in service. With the engine and gear in position on the engine bed, arrangements must be made to have a controlled lifting or lowering of each of the four corners of the engine. If threaded holes are provided in each of the engine mounts, jacking screws can then be used. The engine can be raised by screwing down or lowered by backing off the desired amount on the screws. Steel plates must be inserted under the jacking screws so that the bolts will not damage the engine bed. Lifting can also be accomplished by the use of chain hoists or properly placed jacks. Adjustable shims are also available and can simplify the alignment procedure particularly for future alignment (Fig. M-1).

It will also be necessary to move the engine and gear from one side or the other on the bed to secure horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and sides to check the parallel alignment of the coupling edges (See Fig. M-2).

As the engine and marine transmission then comes into its aligned position, it will be possible to match the male and female halves of the propeller coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. A 0.002-inch feeler gauge is inserted between the flanges of the coupling. The feeler gauge is run completely around the coupling.

Then the marine transmission flange coupling is rotated 90, 180 and 270 degrees with the feeler being run around the flange again in each successive position. If the alignment is correct, the feeler gauge fits snugly with the same tension all around the flange coupling.

If the alignment varies during rotation, then further alignment is necessary or the marine transmission and shaft couplings should be checked for improper face run-out. Face run-out on the marine transmission coupling can usually be corrected by repositioning the coupling on its spline. Shaft coupling run-out is usually due to inaccuracy of taper fit or key interference.

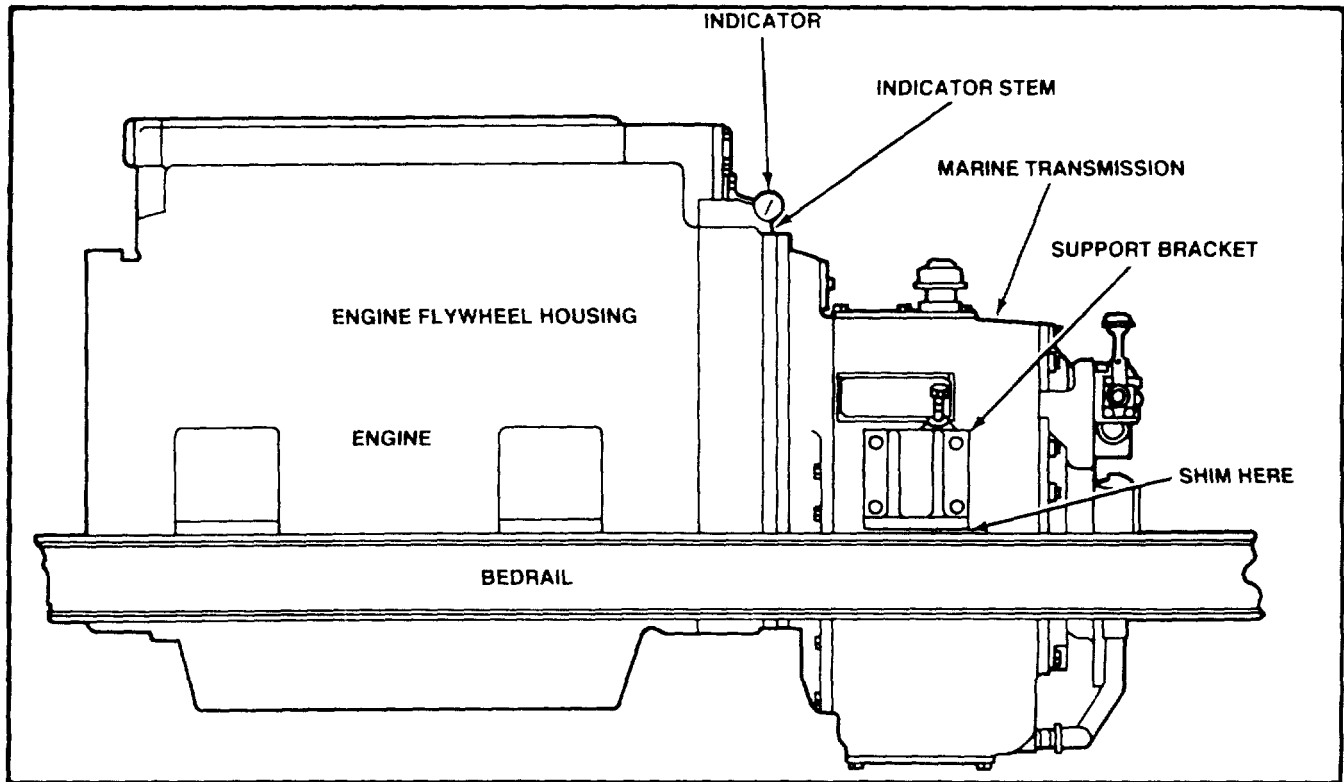


FIGURE M-1: Alignment of Engine and Marine Transmission-Schematic (Typical)

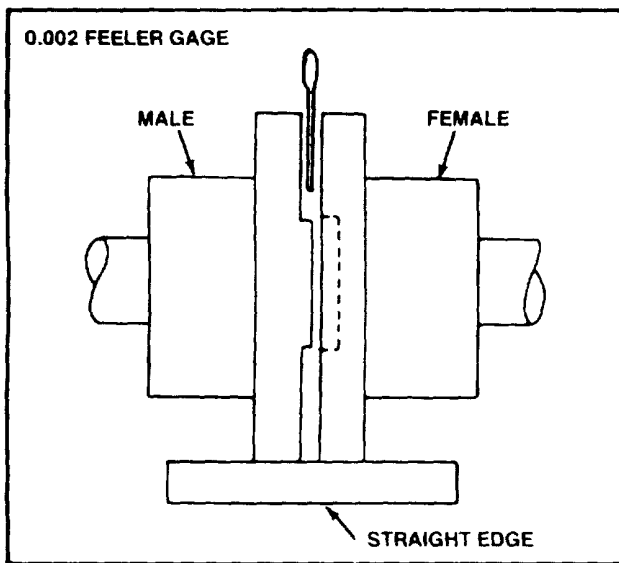


FIGURE M-2: Checking Parallel Alignment of the Coupling Edges

Some boats are not structurally rigid and some carry their load in such a way that they will "hog" or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine transmission and propeller coupling. This

clearance might be 0.005 to 0.007 inch while the top would maintain the standard 0.002 inch.

During the process of securing final alignment, it may be necessary to shift the engine many times. When it becomes apparent that the alignment is reasonably close, the holes for the lag studs are marked and drilled. Then with final alignment completed, the necessary steel or hardwood shims are produced and the engine and gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.




Although it is not as necessary to align a flexible coupling as accurately as a solid coupling, the closer it is in the initial alignment, the more vibration-free it will be. The most accurate method of alignment is to align the shaft to the marine transmission while the flexible coupling is not connected. This can be done with a spacer the same size as the coupling but not flexible in nature. Flexible couplings are used only for noise and vibration damping... not to correct inadequate alignment.

When the heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine transmission coupling and prevent bending of the shaft.

TORQUE VALUES N

TORQUE VALUES: FOR TIGHTENING BOLTS & NUTS					LIMITING CONDITIONS				
DIN GRADE	6.9	8.8	10.9	12.9	DIN GRADE	6.9	8.8	10.9	12.9
METRIC THREAD FINE THREADS	TORQUE VALUES				METRIC THREAD FINE THREADS	TORQUE VALUES			
	lb.-ft. Kgm	lb.-ft. Kgm	lb.-ft. Kgm	lb.-ft. Kgm		lb.-ft. Kgm	lb.-ft. Kgm	lb.-ft. Kgm	lb.-ft. Kgm
M 5 x 0,5	4,5	5	7,3	8,7	M 5 x 0,8	3,6	4,5	6,5	8
	0,6	0,7	1,0	1,2		0,5	0,6	0,9	1,1
M 6 x 0,5	7,2	9,5	12,3	15,2	M 6 x 1	6,5	8,0	10,8	14
	1,0	1,3	1,7	2,1		0,9	1,1	1,5	1,8
M 8 x 1	19,5	22	30	36	M 8 x 1,25	16	18	25	31
	1,7	3,0	4,1	5,0		2,2	2,5	3,4	4,3
M 10 x 1	36	41	57	69	M 10 x 1,5	31	34	47	60
	5,0	5,5	7,8	9,5		4,3	4,7	6,5	8,3
M 12 x 1,5	60	69	98	118	M 12 x 1,75	53	56	82	100
	8,3	9,5	13,5	16		7,3	7,8	11,3	14,0
M 14 x 1,5	92	104	146	176	M 14 x 2	80	86	126	155
	12,8	14	20	24		11	12	17,5	21,5
M 16 x 1,5	130	148	210	253	M 16 x 2	123	130	188	224
	18	20	29	35		17	18	26	31
M 18 x 1,5	180	195	282	340	M 18 x 2,5	166	181	260	310
	25	27	39	47		23	25	36	43
M 20 x 1,5	246	256	362	435	M 20 x 2,5	228	242	340	405
	34	35	50	60		31,5	33,5	47	56
M 22 x 1,5	311	326	450	535	M 22 x 2,5	304	311	434	505
	43	45	63	74		42	43	60	70

TORQUE VALUES - FOR TIGHTENING CAPSCREWS, BOLTS & PIPE PLUGS.

CAPSCREWS, BOLTS & NUTS (1)					
TORQUE (LB.-FT.) FOR COARSE AND FINE THREADS					
NOMINAL THREAD DIAMETER (INCHES)	SAE GRADE 5		SAE GRADE 8 (4)		Screws for Univ. Joint Bearing Caps OILED (3)
	DRY (2)	OILED (3)	DRY (2)	OILED (3)	
1/4	11-10	9-8	16-14	13-11	
5/16	21-19	17-15	30-27	24-21	
3/8	38-34	30-27	53-48	42-38	
7/16	55-50	44-40	78-70	62-56	67-60
1/2	85-77	68-61	118-108	95-86	105-95
9/16	125-115	100-90	177-162	140-127	
5/8	175-160	140-125	245-225	195-177	200-180
3/4	300-270	240-215	420-380	335-305	345-315
7/8	450-405	360-325	630-570	505-460	535-485
1	680-610	545-490	1100-1000	880-792	
1 1/8	860-770	690-620	1390-1250	1110-1010	
1 1/4	1150-1030	920-830	1860-1670	1490-1350	
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>3 DASHES 120° APART</p>  </div> <div style="text-align: center;"> <p>6 DASHES 60° APART</p>  </div> <div style="text-align: center;">  <p>12 Pt. Head Undercut Body</p> </div> </div> <p style="text-align: center;">SAE STANDARD HEX BOLT HEAD MARKINGS</p>					

PIPE PLUGS		
RECOMMENDED TORQUE (LB.-FT.)*		
NPT DIAMETER (INCHES)	IRON, STEEL & BRASS PLUG OR FITTINGS	
	IN CAST IRON OR STEEL	IN ALUMINUM
1/16	6.2-4.5	
1/8	10-7.5	
1/4	20-15	
3/8	25-19	
1/2	47-35	
3/4	59-44	
1	100-80	
1 1/4	130-105	
1 1/2	150-120	

* MUST BE USED WITH COMPOUND, JOHN CRANE INSOLUBLE PLASTIC LEAD SEAL NO. 2 OR EQUIVALENT.

THIS TABLE COVERS TIGHTENING TORQUES FOR LEAK PROOF JOINTS SEALING OIL UP TO 500 PSI AND AIR UP TO 100 PSI AND VACUUM LINES. CAN USE 2/3 OF ABOVE VALUES IF NOT OVER 5 PSI OIL OR 3 PSI AIR IS BEING SEALED. TORQUING HOT UNITS TENDS TO CAUSE MORE DIFFICULT PLUG REMOVAL.

- (1) TORQUE VALUES FOR CAPSCREWS AND BOLTS ALSO APPLY TO USE IN ALUMINUM PROVIDED THE THREAD ENGAGEMENT IS TWICE THE NOMINAL THREAD DIAMETER AND A HARDENED FLAT STEEL WASHER IS USED UNDER THE HEAD. THIS TABLE COVERS TIGHTENING TORQUES FOR THE MAJORITY OF CAPSCREWS AND BOLTS IN THREADED STEEL. CAST IRON, ALUMINUM AND BRASS PARTS. INDIVIDUAL ASSEMBLY DRAWINGS WILL SHOW SPECIAL REQUIREMENTS.
- (2) USE FOR ALL CAPSCREWS, BOLTS AND NUTS WHEN DRY OR COATED ONLY WITH A RUST PREVENTATIVE WHICH IS DRY TO THE TOUCH.
- (3) USE FOR ALL FASTENERS LUBRICATED WITH MOLY-DISULFIDE, WHEN PLATED WITH ZINC OR CADMIUM, OR WHEN DIPPED IN LUBRICATING OIL.
- (4) SOCKET HEAD SCREWS AND 12 POINT HEAD SCREWS WITH FULL BODY ARE ALSO GRADE 8.

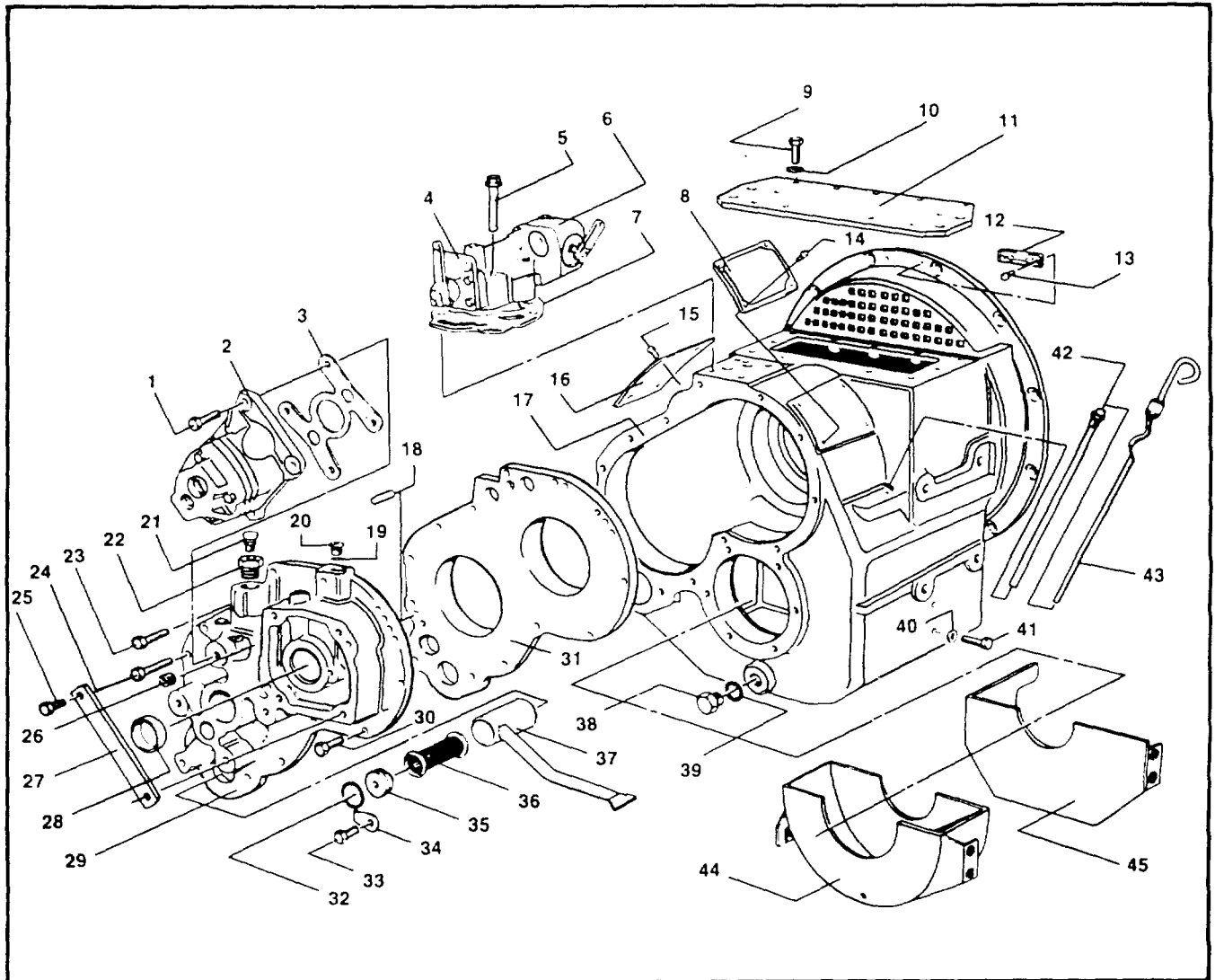


FIGURE O-1: Housing Assembly-Exploded View.

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	CAPSCREW	4	24	CAPSCREW	3
2	PUMP, hydraulic	1	25	CAPSCREW	2
3	GASKET	1	26	PLUG	1
4	VALVE ASSY. selector (Fig O-2)	1	27	RETAINER, plate	1
5	SCREW, 12 point head	4	28	PLUG, core	1
6	VALVE. trolling (optional)		29	MANIFOLD ASSY	1
7	GASKET (Fig. O-2)		30	CAPSCREW	7
8	PLATE, instruction	1	31	BEARING, carrier	1
9	CAPSCREW. hex-head	11	32	"O" RING	1
10	WASHER	11	33	CAPSCREW	1
11	COVER. top	1	34	PLATE, clamp	1
12	PLATE, rotation indicator	1	35	PLUG, "O" ring	1
13	SCREW, drive	2	36	FILTER, screen	1
14	SCREW. drive	4	37	TUBE, suction	1
15	SCREW, drive	4	38	PLUG, "O" ring	1
16	PLATE, name	1	39	"O" RING	1
17	HOUSING, main ,	1	40	SEALING, washer	4
18	PIN, dowel	2	41	CAPSCREW	4
19	"O" RING	4	42	TUBE ASSY, gauge level	1
20	PLUG, "O" ring	4	43	GAUGE, oil level	1
21	BREATHER	1	44	DAM, oil (Except 3.10:1 ratio)	1
22	REDUCER,. bushing	1	45	DAM,. oil 3.10:1 ratio only)	1
23	CAPSCREW	2			

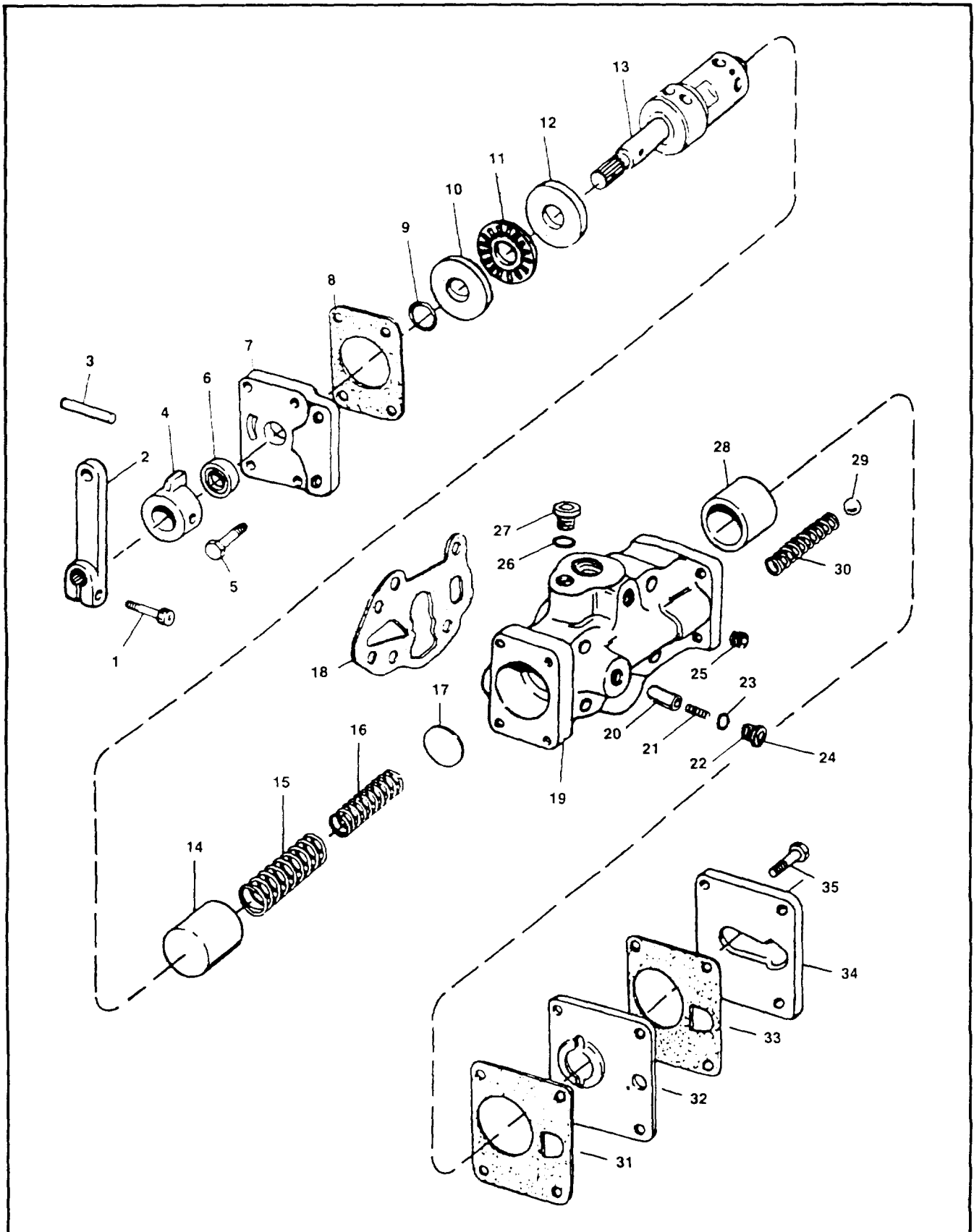


FIGURE O-2: Selector Valve Assembly-Exploded View.

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	CAPSCREW	1	19	BODY, valve	1
2	LEVER, shift	1	20	DETENT	1
3	ROLLPIN	1	21	SPRING, detent	1
4	STOP, collar	1	22	SPRING, detent	1
5	CAPSCREW	4	23	"O" RING	1
6	SEAL, oil	1	24	PLUG	1
7	COVER	1	25	PLUG	1
8	COVER, gasket	1	26	"O" RING	1
9	"O" RING	1	27	PLUG	1
10	RACE	1	28	PISTON, rate of rise	1
11	NEEDLE, thrust	1	29	BALL, steel	1
12	RACE	1	30	SPRING	1
13	STEM, valve	1	31	GASKET, orifice plate	1
14	PISTON, regulation	1	32	PLATE, orifice	1
15	SPRING, outer	1	33	GASKET, orifice plate	1
16	SPRING, inner	1	34	COVER, orifice plate	1
17	SHIM	as req'd	35	CAPSCREW	4
18	GASKET	1			

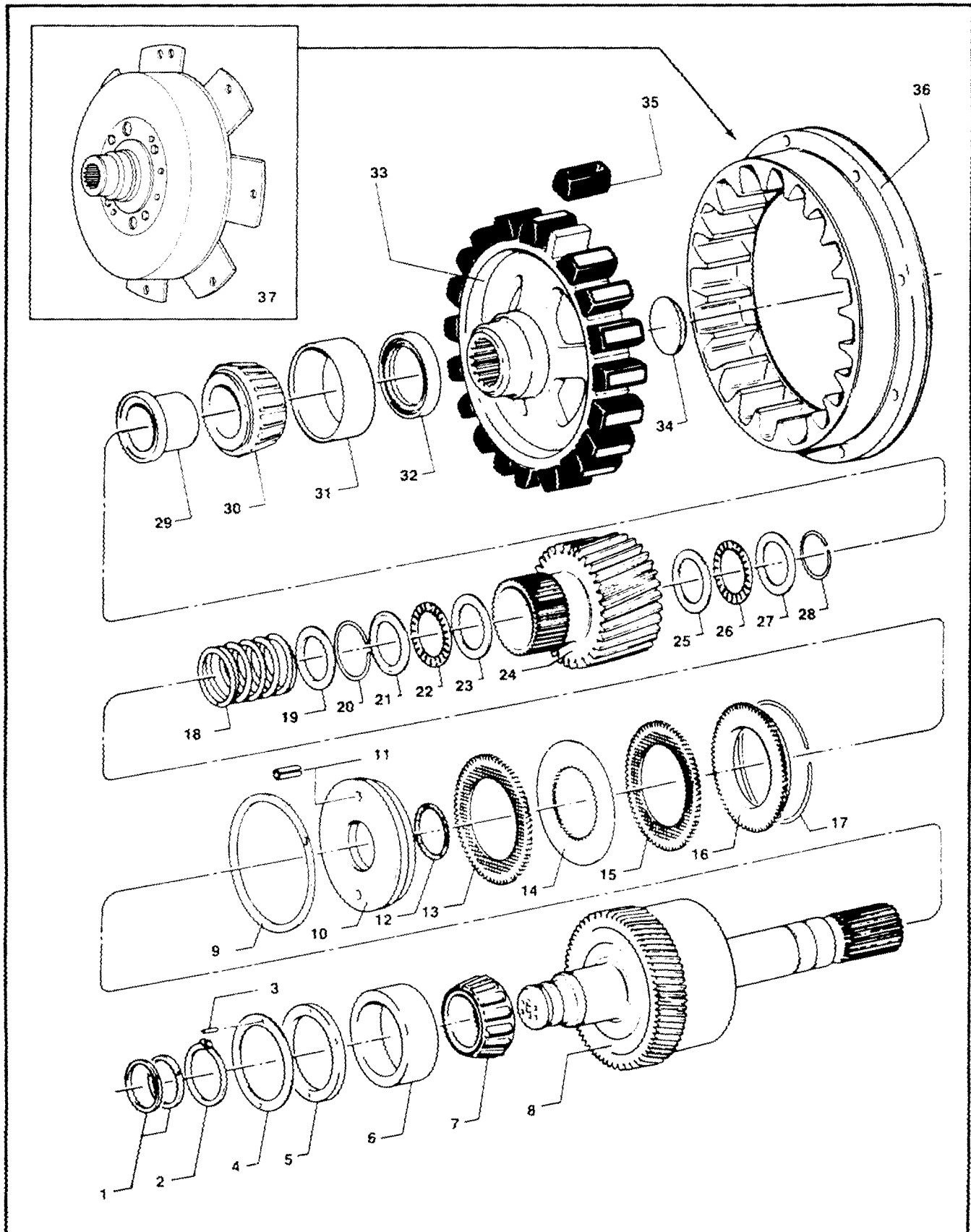


FIGURE O-3: Forward Clutch-Exploded View.

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	RING, piston	2	18	SPRING, return	1
2	SNAP RING, external	1	19	SPRING, retainer	1
3	ROLLPIN	1	20	SNAP RING, internal	1
4	SHIM (0.005)	as req'd	21	THRUST RACE	1
	SHIM (0.007)	as req'd	22	THRUST BEARING, need e	1
	SHIM (0.010)	as req'd	23	THRUST RACE	1
	SHIM (0.020)	as req'd	24	PINION asm	1
5	SPACER	1	25	THRUST RACE	1
6	BEARING, outer race		26	THRUST BEARING, needle	1
7	BEARING, inner race	1	27	THRUST RACE	1
8	SHAFT & GEAR asm	1	28	SNAP RING, external	1
9	RING, piston	1	29	CARRIER, bearing	1
10	PISTON, clutch	1	30	BEARING, inner race	1
11	ROLLPIN	2	31	BEARING, outer race	
12	"O" RING	1	32	SEAL, oil	1
13	PLATE, sintered	7	33	DRIVE, spider	1
14	PLATE, steel	8	34	PLUG, expansion	1
15	PLATE, sintered 1-side	2	35	BLOCK, rubber	26
16	PLATE, back	1	36	RING, drive asm	1
17	SNAP RING, internal	1	37	COUPLING, torsional	1

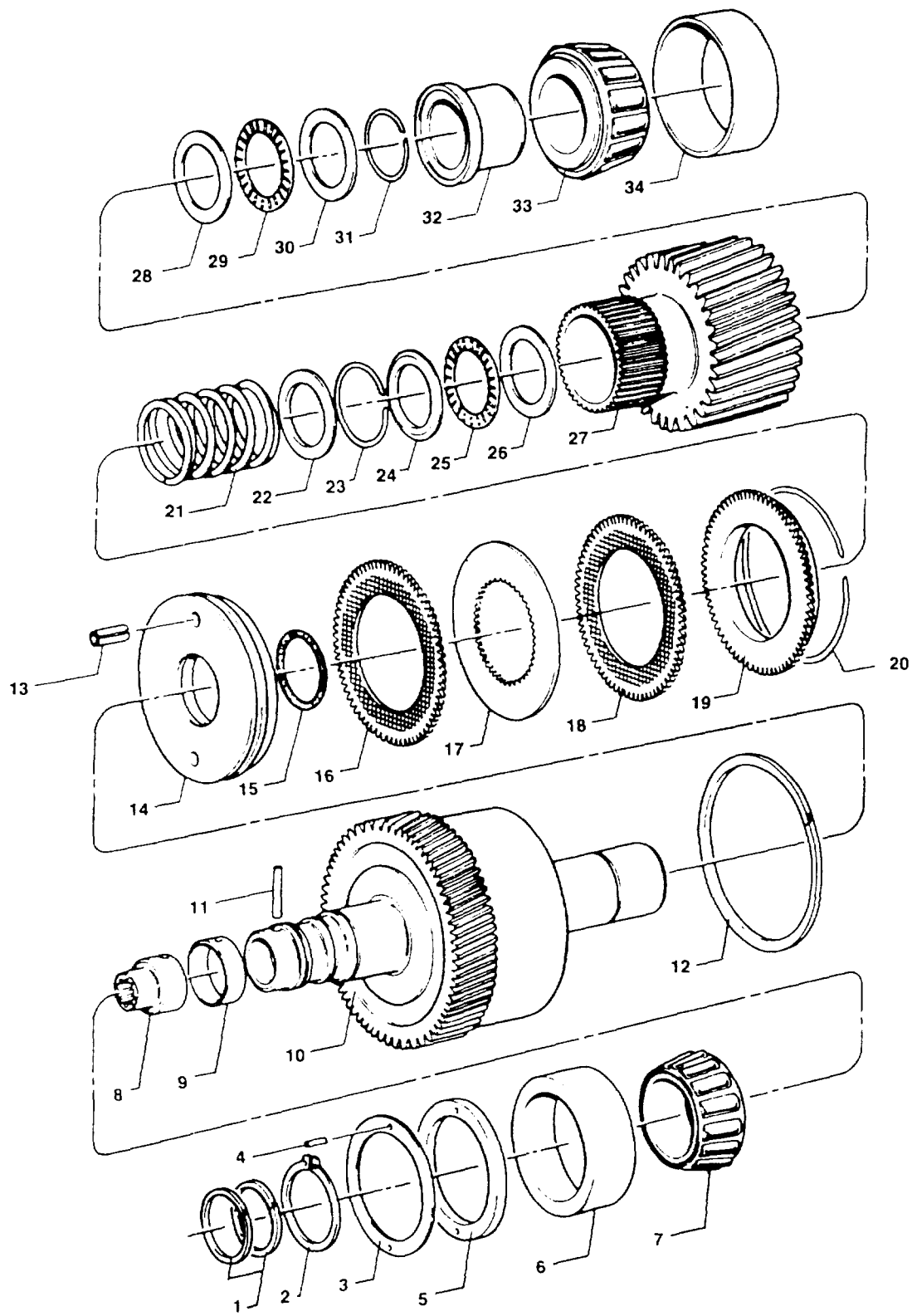


FIGURE O-4: Reverse Clutch-Exploded View.

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	RING, piston	2	17	PLATE, steel	8
2	SNAP RING. external	1	18	PLATE, sintered 1-side	2
3	SHIM (0.005)	as req'd	19	PLATE. back	1
	(0.007)	as req'd	20	SNAP RING, internal	1
	(0.010)	as req'd	21	SPRING, return	1
	(0.020)	as req'd	22	SPRING, retainer	1
4	ROLLPIN	1	23	SNAP RING, internal	1
5	SPACER	1	24	THRUST RACE	1
6	BEARING, outer race		25	THRUST BEARING, needle	1
7	BEARING, inner race	1	26	THRUST RACE	1
8	ADAPTER, pump drive	1	27	PINION asm	1
9	SLEEVE. wear	1	28	THRUST RACE	1
10	SHAFT & GEAR asm	1	29	BEARING, needle	1
11	PIN, drive	1	30	THRUST RACE	1
12	RING. piston	1	31	SNAP RING	1
13	ROLLPIN	2	32	CARRIER. bearing	1
14	PISTON, clutch	1	33	BEARING RACE, inner	1
15	"O" RING	1	34	BEARING RACE, outer	1
16	PLATE, sintered	7			

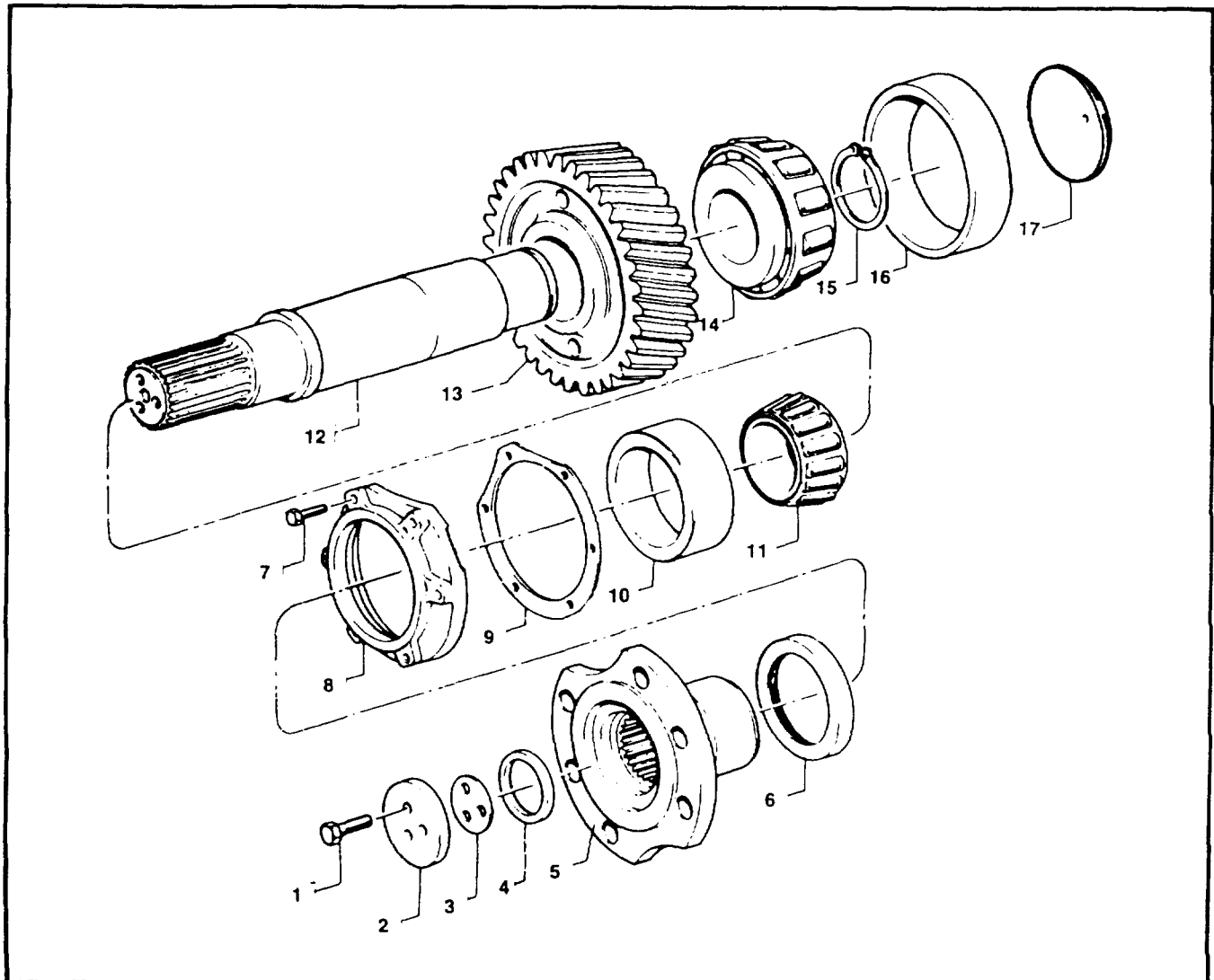


FIGURE O-5: Output Shaft Assembly-SC-Exploded View.

RATIOS 1.12 thru 3.10:1

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	CAPSCREW	3	9	SHIM (0.005)	as req'd
2	WASHER, retainer	1		(0.007)	as req'd
3	SHIM (0.005)	as req'd		(0.010)	as req'd
	(0.007)	as req'd		(0.020)	as req'd
	(0.020)	as req'd	10	BEARING, outer race	-
4	RING, lathe cut	1	11	BEARING, inner race	1
5	FLANGE, output	1	12	SHAFT, output	1
6	SEAL, oil	1	13	GEAR, output	1
7	CAPSCREW	6	14	BEARING, inner race	1
8	CARRIER, output seal	1	15	SNAP RING, external	1
			16	BEARING, outer race	-
			17	PLUG, expansion	1

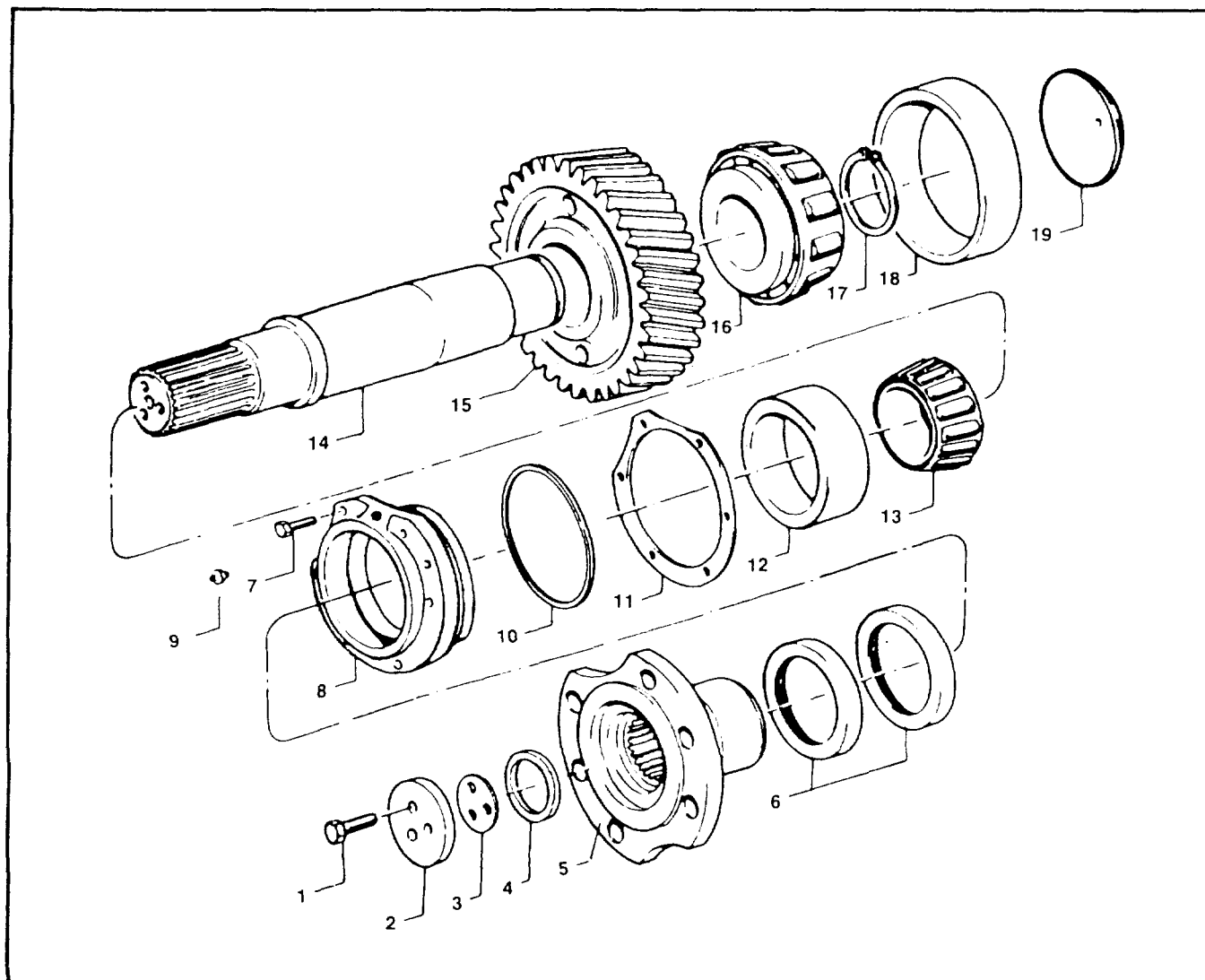


FIGURE O-6: Output Shaft Assembly-DC-Exploded View.

RATIOS 3.92, 4.44, 4.95:1

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	CAPSCREW	3	11	SHIM (0.005)	as req'd
2	WASHER, retainer	1		(0.007)	as req'd
3	SHIM (0.005)	as req'd		(0.010)	as req'd
	(0.007)	as req'd		(0.020)	as req'd
	(0.020)	as req'd	12	BEARING, outer race	
4	RING, lathe cut	1	13	BEARING, inner race	1
5	FLANGE, output	1	14	SHAFT, output	1
6	SEAL, oil	2	15	GEAR, output	1
7	CAPSCREW	8	16	BEARING, inner race	1
8	CARRIER, output seal	1	17	SNAP RING, external	1
9	FITTING, lube	1	18	BEARING, outer race	
10	"O" RING	1	19	PLUG, expansion	1

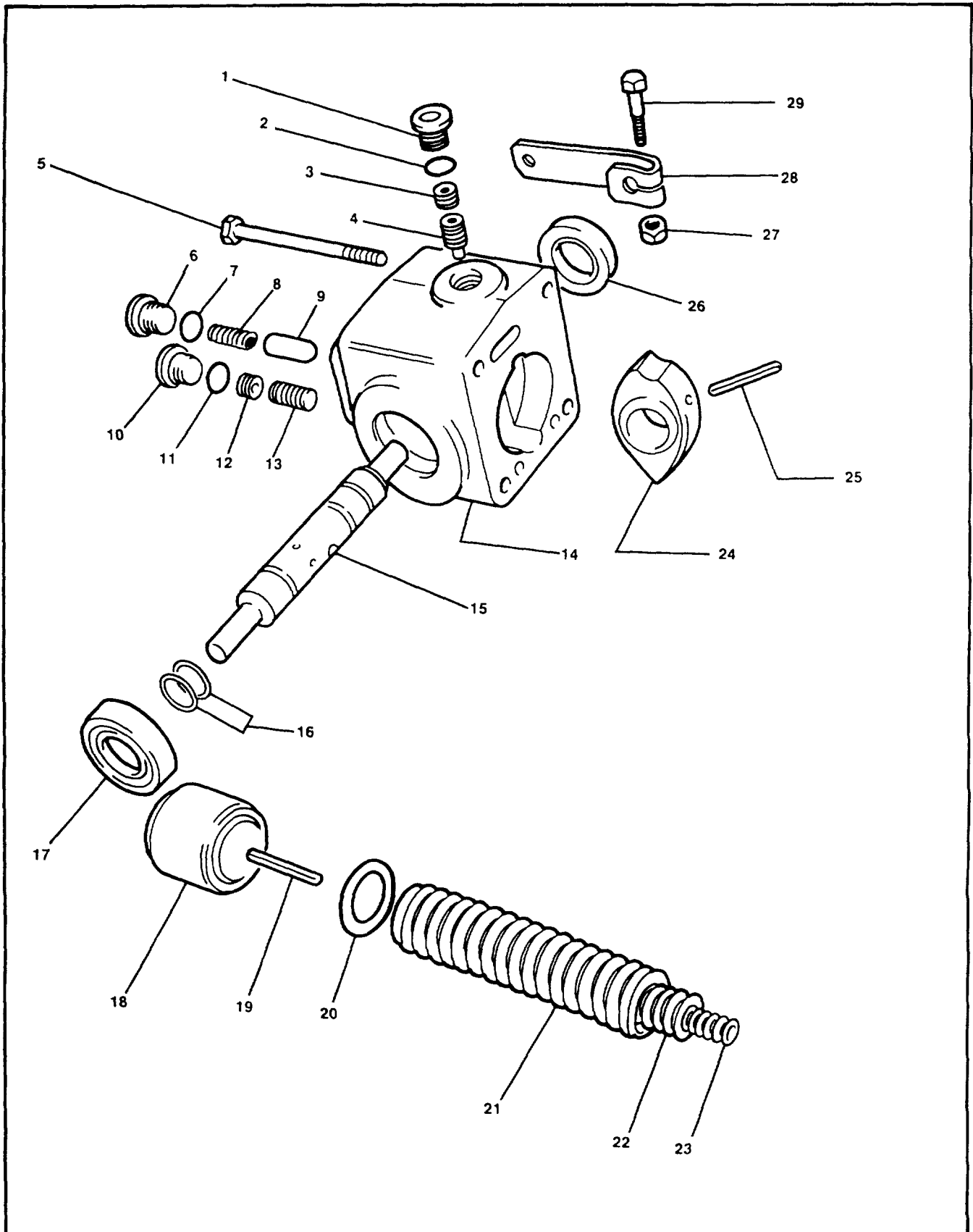


FIGURE O-7: Trolling Valve Assembly 23505391-Exploded View

ITEM	DESCRIPTION	QUANTITY	ITEM	DESCRIPTION	QUANTITY
1	PLUG, O-ring	1	18	PISTON (rate-of-rise)	1
2	O-RING	1	19	PIN, roll, piston	1
3	SCREW, lock	1	20	SHIM, control & trolling pressure	
4	SCREW, set, dog point	1		SHIM (0.005)	
5	SCREW, hex-head	4		SHIM (0.007)	
6	PLUG, O-ring	1		SHIM (0.020)	
7	O-RING	1		SHIM, control pressure 005	
8	SPRING, detent	1		SHIM, trolling pressure .005	
9	DETENT	1	21	SPRING, outer	1
10	PLUG, O-ring	1	22	SPRING, middle	1
11	O-ring	1	23	SPRING, inner	1
12	SCREW, lock	1	24	CAM	1
13	SCREW, set, cam	1	25	ROLLPIN	1
14	COVER ASM, trolling	1	26	SEAL OIL	1
15	SHAFT, trolling valve	1	27	NUT, hex	1
16	O-RING	2	28	LEVER, shift (trolling valve)	1
17	SEAL OIL	2	29	SCREW, hex-head	1

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APPENDIX A

MAINTENANCE ALLOCATION CHART (MAC)

Section I. INTRODUCTION

A-1 THE ARMY MAINTENANCE SYSTEM MAC.

a. This introduction (Section I) provides a general explanation of all maintenance and repair functions authorized at various maintenance levels under the standard Army Maintenance System concept.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or components will be consistent with the capacities and capabilities of the designated maintenance levels, which are shown in the MAC in column (4) as:

Unit - includes two subcolumns: C (operator/crew) and O (unit) maintenance.
 Direct Support - includes an F subcolumn.
 General Support - includes an H subcolumn.
 Depot - includes a D subcolumn.

c. Section III lists the tools and test equipment (both special tools and common tools sets) required for each maintenance function referenced from Section II.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function as referenced from Section II.

A-2 MAINTENANCE FUNCTIONS . Maintenance functions will be limited to and defined as follows:

a. Inspect. To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination (i.e., by sight, sound, or feel).

b. Test. To verify serviceability by measuring the mechanical, pneumatic, hydraulic, or electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. Service. Operations required periodically to keep an item in proper operating condition, i.e., to clean (includes decontamination, when required), to replace filters, to preserve, to drain, to paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. Adjust. To maintain or regulate, within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to specified parameters.

e. Align. To adjust specified variable elements of an item to bring about optimum or desired performance.

f. Calibrate. To determine and cause corrections to be made or to be adjusted on instruments or test, measuring, and diagnostic equipment used in precision measurement. Consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. Remove/Install. To remove and install the same item when required to perform service or other maintenance functions. Install may be the act of emplacing, seating, or fixing into position a spare, repair part, or module (component or assembly) in a manner to allow the proper functioning of an equipment or system.

h. Replace. To remove an unserviceable item and install a serviceable counterpart in its place. Replace is authorized by the MAC and is shown as the 3rd position code of the SMR code.

i. Repair. The application of maintenance services¹ including fault location/troubleshooting², removal/installation, and disassembly/assembly³ procedures, and maintenance actions⁴ to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), and item, or system.

j. Overhaul. That maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like new condition.

k. Rebuild. Consists of those service/actions necessary for the restoration of unserviceable equipment to a like new condition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipment and components.

A-3 EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

a. Column 1 - Group Number. Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly.

b. Column 2 - Component/Assembly. Column 2 contains the names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. Column 3 - Maintenance Function. Column 3 lists the functions to be performed on the item listed in column 2. (For detailed explanation of these functions, see paragraph A-2.)

d. Column 4 - Maintenance Category. Column 4 specifies, by the listing of a work time figure in the appropriate subcolumn(s), the category of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated category of maintenance. If the number or complexity of the tasks within the listed maintenance function varies at different maintenance categories, appropriate work time figures will be shown for each category. The work time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fault location time, and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the

¹Service - Inspect, test, service, adjust, align, calibrate, and/or replace.

²Fault location/troubleshooting - The process of investigating and detecting the cause of equipment malfunctioning; the act of isolating a fault within a system or unit under test (UUT).

³Disassembly/assembly - The step-by-step breakdown (taking apart) of a spare/functional group coded item to the level of its least component, that is assigned an SMR code for the level of maintenance under consideration (i.e., identification as maintenance significant).

⁴Actions - Welding, grinding, riveting, straightening, facing, machining, and/or resurfacing.

maintenance functions authorized in the maintenance allocation chart. The symbol designations for the various maintenance categories are as follows:

- C Operator or Crew
- O Unit Maintenance
- F Direct Support Maintenance (DS)
- H General Support Maintenance (GS)
- D Depot Maintenance

e. Column 5 - Tools and Equipment. Column 5 specifies, by number code, those common tool sets (not individual tools) and special tools; Test, Measurement, and Diagnostic Equipment (TMDE); and support equipment required to perform the designated function, which shall be keyed to the tools listed in Section III.

f. Column 6 - Remarks. This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

A-4 EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. Column 1 - Reference Code. The tool and test equipment reference code correlates with a number code used in the MAC, Section II, Column 5.

b. Column 2 - Maintenance Category. The lowest category of maintenance authorized to use the tool or test equipment.

c. Column 3 - Nomenclature. Name or identification of the tool or test equipment.

d. Column 4 - National Stock Number. The National stock number (NSN) of the tool or test equipment.

e. Column 5 - Tool Number. The manufacturer's part number.

A-5 EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

a. Column 1 - Reference Code. The letter code recorded in Column 6, Section II.

b. Column 2 - Remarks. This column lists information pertinent to the maintenance function being performed as indicated in the MAC, Section II.

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0	Modular Causeway Ferry (MCF)	INSPECT SERVICE	2.0 2.0	6.0 6.0	2.0 2.0	4.0		1-11 1-12	C F
01	Powered Section Assembly	INSPECT SERVICE TEST	2.0 2.0 0.5	2.0				1-11 1-12	C F
0101	P40P Propulsion Module Assembly	INSPECT SERVICE REPAIR TEST	4.0 8.0 2.0 0.5			4.0		1-11 1-13 1-13	C, G A, C, E, F C, G
010101	Engine Cooling System Install.	INSPECT REPLACE REPAIR TEST	0.5 0.5 0.5 0.5	1.5 1.5					C, G
01010101	Duplex Strainer	SERVICE REPAIR REPLACE ADJUST		1.5 1.0 0.5	1.0			11 12 12 12	C B
010102	Drive Train Installation	INSPECT SERVICE REPLACE REPAIR ALIGN	1.0 0.5	1.5 0.5	1.0 2.0	2.0			C, G C, G C, G C, G
01010201	Diesel Engine	INSPECT SERVICE REPLACE REPAIR TEST ADJUST	1.5 1.0 2.0	1.0 2.0 10.0 2.0	2.0 8.0 24.0 1.0	12.0 1.0	63.5	11 1-12 12 11	C C H H
0101020101	Cylinder Block Group	REPLACE REPAIR				4.0 4.0		12 12	I, K I, K
010102010101	Block Assembly	REPLACE REPAIR				4.0 6.2		12 12	I, K I, K
010102010102	Plate Assembly	REPLACE REPAIR				2.0 4.0		12 12	I, K I, K
010102010103	Plate Assembly	REPLACE REPAIR				2.0 4.0		12 12	I, K I, K
0101020102	Air Box Drains Group	REPLACE REPAIR		1.0 1.4				12 12	K K
0101020103	Cylinder Head Group	INSPECT REPLACE REPAIR			0.6 8.0	2.1		12 12	B, K K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
010102010301	Cylinder Head Assembly	REPLACE REPAIR			4.0	10.0		12 12	I, K I, K
0101020104	Engine Lifter Brackets Group	REPLACE REPAIR			0.5 0.5			12 12	K K
0101020105	Crankshaft and Stabilizers Group	REPLACE REPAIR				1.5 5.6		12 12	I, K I, K
010102010501	Crank Assembly	REPLACE REPAIR				1.0 10.0		12 12	I, K I, K
0101020106	Vibration Damper Group	REPLACE REPAIR			1.0 2.6			12 12	K K
010102010601	Hub Assembly	REPLACE REPAIR			0.5 1.0			12 12	I, K I, K
0101020107	Crankshaft Pulley Group	REPLACE REPAIR			1.0 1.0			12 12	K K
0101020108	Flywheel Housing Group	REPLACE REPAIR				0.5 2.0		12 12	K K
0101020109	Flywheel Group	REPLACE REPAIR				1.0 4.0		12 12	K K
010102010901	Flywheel Assembly	REPLACE REPAIR				4.0 4.0		12 12	I, K I, K
0101020110	Connecting Rod and Piston Group	REPLACE REPAIR				4.0 4.0		12 12	K K
010102011001	Rod Assembly	REPLACE REPAIR				2.0 2.0		12 12	I, K I, K
0101020111	Camshaft and Gear Train Group	REPLACE REPAIR				7.0 8.0		12 12	K K
010102011101	Hub Assembly	REPLACE REPAIR				2.0 2.0		12 12	I, K I, K
0101020112	Balance Weight Cover Group	REPLACE REPAIR				1.0 1.0		12 12	K K
010102011201	Cover Assembly	REPLACE REPAIR				0.5 0.5		12 12	I, K I, K
0101020113	Valve and Injector Operator Group	REPLACE REPAIR				1.4 1.6		12 12	K K
010102011301	Shaft Assembly	REPLACE REPAIR				0.5 0.5		12 12	I, K I, K
010102011302	Left Arm Assembly	REPLACE REPAIR				0.5 0.5		12 12	I, K I, K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
010102011303	Right Arm Assembly	REPLACE				0.5		12	I, K
		REPAIR				0.5		12	I, K
010102011304	Clevis Arm Assembly	REPLACE				0.5		12	I, K
		REPAIR				0.5		12	I, K
0101020114	Rocker Cover Group	REPLACE			0.5			12	K
		REPAIR			0.5			12	K
0101020115	Fuel injector/Change Controls Group	REPLACE				1.6		12	K
		REPAIR				2.2		12	K
0101020117	Fuel Pump Group	REPLACE				0.5		12	K
		REPAIR				1.7		12	K
010102011701	Pump Assembly	REPLACE				1.0		12	I, K
		REPAIR				1.0		12	I, K
0101020118	Fuel Filter Mounting Group	REPLACE		0.4				12	K
		REPAIR		0.4					
0101020119	Fuel Manifold and Connections Group	REPLACE				0.4		12	K
		REPAIR				0.8		12	K
010102011901	Pipe Assembly	REPLACE				0.5		12	I, K
		REPAIR				0.5		12	I, K
010102011902	Pipe Assembly	REPLACE				0.5			
		REPAIR				0.5		12	I, K
0101020120	Fuel Lines Filter and Cooler Group	REPLACE		1.0				12	K
		REPAIR		1.8				12	K
010102012001	Fuel/Water Separator	SERVICE		0.5					
		REPLACE		1.0				12	I, K
		REPAIR		1.0				12	I, K
0101020121	Electric Governor Group	REPLACE			1.0			12	K
		REPAIR			1.5			12	K
		ADJUST			0.5			12	K
010102012101	Housing Assembly	REPLACE			0.3			12	I, K
		REPAIR			0.3			12	I, K
0101020122	Injector Controls Group	REPLACE			1.5			12	K
		REPAIR			3.0			12	K
010102012201	Lever Assembly	REPLACE			0.5			12	I, K
		REPAIR			0.5			12	I, K
010102012202	Modulator Assembly	REPLACE			0.5			12	I, K
		REPAIR			0.5			12	I, K
0101020123	Air Inlet Housing Group	SERVICE			1.5			12	K
		REPLACE			1.5			12	K
		REPAIR			1.5			12	K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
010102012301	Housing Assembly	REPLACE REPAIR			1.5 1.5			12 12	I, K I, K
0101020124	Blower and Drive Group	REPLACE REPAIR			2.0 2.0			12 12	K K
010102012401	Blower Assembly	REPLACE REPAIR			2.0 2.0			12	I, K
010102012402	Rotor Assembly	REPLACE REPAIR			2.0 2.0			12 12	I, K I, K
010102012403	Rotor Assembly	REPLACE REPAIR			2.0 2.0			12 12	I, K I, K
010102012404	Plate Assembly	REPLACE REPAIR			2.0 2.0			12 12	I, K I, K
01012012405	Plate Assembly	REPLACE REPAIR			2.0 2.0			12 12	I, K I, K
010102012406	Connector Assembly	REPLACE REPAIR			3.0 3.0			12 12	I, K I, K
0101020125	Blower Drive Shaft Group	REPLACE REPAIR			1.5 1.5			12 12	K K
0101020126	Turbocharger Group	REPLACE REPAIR			1.0	0.5		12 12	K K
010102012601	Aftercooler Assembly	REPLACE REPAIR				2.0 2.0		12	I, K
0101020127	Oil Pump Group	REPLACE REPAIR				1.5 3.0		12	K
010102012701	Pump Assembly	REPLACE REPAIR				1.0 1.0		12	I, K
0101020128	Oil Distribution System Group	REPLACE REPAIR				2.0 3.7		12	K
0101020129	Oil Pressure Regulator Group	REPLACE REPAIR				1.5 2.1		12	K
010102012901	Regulator Assembly	REPLACE REPAIR				1.0 1.0		12	I, K
010102012902	Valve Assembly	REPLACE REPAIR				1.0 1.0		12	I, K
0101020130	Oil Filter Group	REPLACE REPAIR		0.5 0.5				12	K
0101020131	Oil Cooler and Marine Gear Lines Group	REPLACE REPAIR			2.5 1.5			12	K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0101020132	Oil Filter Group	REPLACE REPAIR		1.0 1.5				12	K
0101020133	Dipstick Group	REPLACE REPAIR		0.5 0.5				12	K
0101020134	Oil Pan Group	REPLACE REPAIR				0.5 2.0		12	K
0101020135	Ventilation System Group	REPLACE REPAIR			1.5 2.0			12	K
010102013501	Collector Assembly	REPLACE REPAIR			1.0 2.5			12	I, K
010102013502	Collector Assembly	REPLACE REPAIR			1.0 2.5			12	I, K
0101020136	Fresh Water Pump Group	REPLACE REPAIR			1.5 3.0			11 12	B K
010102013601	Pump	REPLACE REPAIR			1.0 1.0			12	I, K
0101020137	Manifold Water Outlet Group	SERVICE REPLACE REPAIR		1.1 1.5 2.0				12 12	K K
0101020138	Thermostat Group	REPLACE REPAIR			1.0 2.0			11	K
0101020139	Water Bypass Tube Group	REPLACE REPAIR		0.5 1.0				12	K
0101020140	Water Connection Group	REPLACE REPAIR				2.5 2.5		12	B
0101020141	Heat Exchanger Group	INSPECT SERVICE REPLACE REPAIR		2.0 2.5				12 12	K K
					2.5 3.5			12	B
010102014101	Electrode Assembly	REPLACE REPAIR			0.5 2.1			12	I, K
0101020142	Raw Water Pump Group	SERVICE REPAIR REPLACE		0.5		3.0		11 12	B, K
					1.5				
010102014201	Pump Assembly	REPLACE REPAIR			1.0 1.0			12	I, K
0101020143	Water Filter Group	SERVICE REPLACE REPAIR		0.75 0.4 0.4				12 12	K K
0101020144	Exhaust Manifold Connections Group	REPLACE REPAIR			1.0 4.0			12	K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0101020145	Exhaust Muffler Connections Group	REPLACE REPAIR		0.5 0.5				12	B
0101020146	Starting Motor Group	REPLACE REPAIR		0.5 1.9				12	
0101020147	Tachometer Drive Group	REPLACE REPAIR		2.0 2.0				12	B
0101020148	Alarm System Group	REPLACE REPAIR			1.0 3.5			12	K
0101020149	Overspeed Governor Group	ADJUST REPLACE REPAIR			1.0 2.0 2.0			12 12	K K
0101020150	Instruments Sending Units Group	REPLACE REPAIR			0.5 1.1			12	K
0101020151	Pushbutton Group	REPLACE REPAIR			0.5 1.0			12	B, K
0101020152	Heater Connections Group	REPLACE REPAIR		1.0 2.0				12	K
0101020153	Alternator and Bracket Group	TEST REPLACE REPAIR ADJUST		0.5 1.0 2.0 0.5				12 12 12	K B K
0101020154	Wire Harness Group	REPLACE REPAIR				2.0 1.0		12	K
0101020155	Cold Pac Starting Aid Group	INSPECT SERVICE REPLACE REPAIR		0.1 0.5 1.5 0.5				12 12 12	
010102015501	Cold Pac Assembly	REPLACE REPAIR		1.5 0.5				12	
0101020156	Fuel Priming Pump Group	REPLACE REPAIR		1.0 1.0				12	B, K
0101020157	Marine Gear	INSPECT SERVICE ADJUST REPLACE REPAIR ALIGN	0.5	0.5 1.0	1.0 6.0 2.0	6.0		12	B, I, K I
010102015701	Electric Control Valve	REPAIR REPLACE				3.0 3.0			
01010202	Transfer Case	INSPECT SERVICE REPLACE REPAIR	0.5	0.5 1.0	2.0	4.0		11 11 12	C, F, K

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
01010203	Pump-Jet	INSPECT SERVICE REPAIR REPLACE	0.5 1.0	0.5 1.5 0.5				11 11 12 12	C, F C, H
0101020301	Upper Gear Box	REPLACE REPAIR				10.0 6.0			
0101020302	Hydro-Motor	REPLACE REPAIR			2.0	3.0			
0101020303	Planetary Gearing	REPLACE REPAIR			2.0	3.0			
0101020304	Feed Back Unit	REPLACE REPAIR SERVICE			0.5 0.5	1.0 0.5			
0101020305	Planetary Gearing	REPLACE REPAIR			2.0	3.0			
01010204	Fast Lube Oil Change System	REPLACE REPAIR	0.5 0.5						
01010205	Tank Assembly	REPLACE REPAIR	0.5 0.5						B
010103	Machinery Guard Installation	REPLACE REPAIR	0.5 0.5					12	B
010104	Installation	Engine Exhaust System REPLACE REPAIR SERVICE	0.25	2.0		.0		11	
01010401	Muffler Assembly	REPAIR REPLACE		0.5 0.5					
01010402	Thru Hull Assembly	REPAIR REPLACE		0.5 0.5					
01010403	Retainer Assembly	REPAIR REPLACE		0.5 0.5					
010105	Hydraulic System Installation	INSPECT SERVICE REPLACE REPAIR ADJUST	1.0	3.0 6.0 4.0 1.0 1.0				11 11 12 12	C C, D, G B
01010501	Hydro-Pump Installation	REPLACE REPAIR ADJUST		1.0 1.0 1.0					
0101050101	Pump	REPLACE REPAIR		1.0		4.0			

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0101050201	Valve	REPLACE REPAIR		1.0		2.5			
01010503	Hydro-Handpump Installation	REPLACE REPAIR SERVICE INSPECT	0.2	1.0 1.0 0.2					
0101050301	Handpump	REPLACE REPAIR		1.0 1.0					
01010504	Ball Valve	REPLACE REPAIR		0.5 0.5					
01010505	Hydraulic Reservoir Assembly	REPLACE REPAIR		2.0 2.0					
0101050501	Return Filter Assembly	REPAIR REPLACE		0.5 0.5					
0101050502	Inspection Cover	REPAIR REPLACE		0.5 0.5					
010106	Bilge System Installation	INSPECT REPLACE REPAIR TEST	1.0	2.0 3.0				11 11 12	C, G B
010107	Fire Suppression System	INSPECT SERVICE REPLACE REPAIR TEST INSTALL	0.25	1.0 1.0 0.5 1.0		1.0			A
010108	Fuel System	INSPECT SERVICE REPLACE REPAIR	0.5 0.5	1.0 1.0 2.5				12 11	C, G
010109	Propulsion Module Electrical Assembly	INSPECT REPAIR REPLACE TEST	0.5 0.5	2.0 2.0				12	B
01010901	Bilge Pump Control Assembly A5 REPAIR	INSPECT REPLACE	0.25 2.0 1.5						B
01010902	Single Bilge Pump Control Assembly A7 REPAIR	INSPECT REPLACE		0.25 2.0 1.5					B
01010903	Engine Junction Box Assembly A4 REPAIR	INSPECT REPLACE		0.25 2.0 1.5					B

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
01010904	Propulsion Module Junction Box A3	INSPECT REPLACE REPAIR		0.25 2.0 1.5					B
01010905	Circuit Breaker Panel Assembly A6	INSPECT REPAIR REPLACE		0.25 1.5 2.0					B
01010906	Battery Installation	INSPECT SERVICE REPLACE REPAIR	0.5 1.5	0.5 0.5 1.5				11 11	C, G F B
01010907	Vent Fan Relay Enclosure Assembly	INSPECT REPLACE REPAIR		0.25 2.0 1.5					B
01010908	Pump-Jet Junction Box Assembly A2	INSPECT REPLACE REPAIR		0.25 2.0 1.5					
01010909	Pump-Jet Dir/Aux. Battery Junction Box A9	INSPECT REPLACE REPAIR		0.25 2.0 1.5					
010110	Emergency Steering System	INSPECT SERVICE REPLACE REPAIR	0.5 0.5	0.5 2.5				12	C, G B
0102	P40 Pontoon Assembly	INSPECT REPLACE REPAIR TEST ADJUST	0.5	0.5 0.5 0.5 1.0			*	1-11, 13	A, B
0103	P20LR Pontoon Assembly	INSPECT REPLACE REPAIR TEST ADJUST	0.5	0.5 0.5 0.5 0.5			*	1-11, 13	A, B
010301	Hatch Assembly	REPAIR REPLACE	0.5 0.5						
0104	P20CR Pontoon Assembly	INSPECT REPLACE REPAIR TEST ADJUST	0.5	0.5 0.5 0.5 0.5			*	1-11, 13	A, B
0105	P20RR Pontoon Assembly	INSPECT REPLACE REPAIR TEST ADJUST	0.5	0.5 0.5 0.5 0.5			*	1-11, 13	A, B

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
010501	Hatch Assembly	REPAIR REPLACE		0.5 0.5					
0106	Operator's Cab	INSPECT SERVICE REPLACE REPAIR	1.5 1.5	1.0 2.5					B
010601	Middle Control Panel A1	INSPECT REPLACE REPAIR	0.5	0.75 0.5 2.0				11	C, G B
01060101	Indicating Device	REPLACE REPAIR		0.5 0.5					
010602	Lower Control Panel A2	INSPECT REPLACE REPAIR	0.5	0.75 0.5 2.0				11	C, G B
010603	Operator's Cab Circuit Breaker Panel A3	INSPECT REPLACE REPAIR		0.25 2.0 1.5					C, G B
010604	Terminal Strip Assembly A4	INSPECT REPLACE REPAIR		0.5 2.0 1.5					C, G B
010605	Stbd Receptacle Assembly A5	INSPECT REPLACE REPAIR		0.5 2.0 1.5					C, G B
010606	Port Receptacle Assembly A6	INSPECT REPLACE REPAIR		0.5 2.0 1.5					C, G B
010607	Spotlight	SERVICE REPLACE REPAIR ADJUST		0.2 1.0 2.0 0.2				12 12 12	B
010608	Junction Box Assembly	INSPECT REPAIR REPLACE		0.5 2.0 1.5					C, G B
010609	Mast Enclosure Assembly	INSPECT REPLACE REPAIR		0.5 2.0 1.5					
0107	Intake Plenum Assembly	INSPECT REPAIR REPLACE	0.2	0.5 0.5				11-13	A
0108	Fender Assembly	REPLACE REPAIR		0.25 0.5					B
0109	Mooring Cleat Assembly	REPLACE REPAIR		0.25 0.5					B

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0110	Mooring D-Ring	REPLACE REPAIR		0.25 0.5					
0111	Exhaust Plenum Assembly	INSPECT REPLACE REPAIR SERVICE	0.2	0.5 1.0 0.25				11-13	B
0112	Stub Mast Navigation Assembly	INSPECT REPLACE REPAIR	0.2	0.2 0.5				2-13	C, G F
011201	Stern Light	REPLACE REPAIR		0.5 1.5					
0113	Main Mast Navigation Assembly	INSPECT REPLACE REPAIR	0.2	1.0 1.0				13	B
011301	Navigation Lights Terminal Box	INSPECT REPAIR REPLACE		0.5 2.0 1.5					
011302	Navigation Light, Starboard	REPLACE REPAIR		1.0 1.5					
011303	Navigation Light, Port	REPLACE REPAIR		1.0 1.5					
011304	Navigation Light, Vessel Aground	REPLACE REPAIR		1.0 1.5					
011305	Navigation Light, Masthead	REPLACE REPAIR		1.0 1.5					
011306	Navigation Light, Anchor	REPLACE REPAIR		1.0 1.5					
011307	Single Task Light	REPLACE REPAIR		1.0 1.5					
0114	Module Electrical Interconnect Assembly	INSPECT REPLACE REPAIR		0.5 0.5		1.5			C, G B B
0115	Anchorboard Assembly	INSPECT SERVICE REPAIR REPLACE	0.5 0.5	2.0 1.0				1-10	C, G F
0116	Railing Installation	INSPECT REPLACE REPAIR	0.5	1.0 0.5					

**Section II. MAINTENANCE ALLOCATION CHART
FOR
MODULAR CAUSEWAY FERRY (MCF)**

(1) Group Number	(2) Component/ Assembly	(3) Maintenance Function	(4) Maintenance Level					(5) Tools and Equipment	(6) Remarks
			Unit		DS	GS	Depot		
			C	O	F	H	D		
0117	Spreader Assembly	INSPECT REPLACE REPAIR TEST SERVICE		0.5 0.5			0.5 1.5 1.5 1.0	1-10 13	C, G F
02	MCF Intermediate Section Assembly	INSPECT	1.0					1-11	C, G
03	MCF Beach End Section	INSPECT	1.0					1-11	C, G
0301	P25B Beach/Sea End Module	INSPECT REPAIR REPLACE TEST ADJUST	0.5	0.5 0.5 0.5 0.25				13	A, B, E
030101	Rhino Horn Assembly	REPLACE REPAIR INSPECT		0.25 0.5 0.5				13	
04	P3 Module Assembly	INSPECT REPLACE REPAIR TEST SERVICE ADJUST	0.5	0.5 0.5 0.5 0.25 0.25					

**Section III. TOOLS AND TEST EQUIPMENT
FOR
MODULAR CAUSEWAY FERRY (MCF)**

TOOL OR TEST EQUIPMENT REF CODE	MAINTENANCE LEVEL	NOMENCLATURE	NATIONAL STOCK NUMBER	TOOL NUMBER
1	C	Bar, Pry, Pinch, 60"	5120-00-224-1384	GGGB-101
2	C	Hammer, Hand, 10 LB	5120-00-251-4489	
3	C	Hammer, Hand, Scaling	5120-00-224-4111	
4	C	Corrosion Remover	1440-01-028-3063	A-29
5	C	Brush, Wire, Scratch	7920-00-291-5815	
6	C	Grease, General Purpose	9150-00-985-7316	MIL-G-23549
7	C	Wrench Set, Combination	5120-00-148-7917	GGG-W-636
8	C	Wrench, Adjustable, 12"	5120-00-264-3796	ANSI-B107-8
9	C	Socket, Thin Wall	5120-00-277-1465	53918
10	O	Tool Kit, Automotive	5180-00-177-7033	
11	O	Wrench, Strap	5120-00-776-1840	
12	O	Wrench, Monkey	5120-00-277-3020	
13	O	Tester, Battery Electrolyte Solution	6630-00-171-5126	GG-T-258
14	O	Tool Kit, Marine & Rail	5180-00-629-9783	
15	O	Flashlight, Regular, Two Cell	6230-00-163-1856	W-F-421
16	O	Fuse Puller and Tester	5120-00-319-3295	34-005
17	O	Multimeter	6625-00-004-9536	
18	O	Tester, Battery	6630-00-171-5126	
19	O	Wrench, Torque, 0-150 FT. LBS	5120-00-247-2540	
20	F	Tool Kit, Welder	5180-00-754-0661	
21	H	Wrench, Spanner		543-1-15X24-9
22	H	Wrench, Torque, 100-500 Ft. LBS	5120-00-542-5577	
23	H	Dial Indicator	5120-00-402-9619	J7872

**Section IV. REMARKS FOR
MODULAR CAUSEWAY FERRY (MCF)**

REMARKS CODE	REMARKS
A	Repair beyond the capabilities of GS units will be performed on a case by case basis subject to funding and approval by the National Maintenance Point (NMP).
B	Repair of this item is by replacement.
C	Accomplish monthly or prior to use and before stowage.
D	Accomplish monthly or after exposure to severe weather (sea state 3) and operator mishandling.
E	Accomplish whenever craft is removed from water.
F	Service includes cleaning, painting, and surface preservation.
G	After every time MCF has accomplished a field/training operation.
H	After return from higher level maintenance.
I	Time does not include engine, Transfer Case, or Pump-Jet removal from MCF.
J	Accomplish in accordance with prescribed military technical manual procedures.
K	Accomplish in accordance with commercial manufacturer maintenance and repair procedures.

A-17/(A-18 blank)

APPENDIX B

COMPONENTS OF END ITEM/
BASIC ISSUE ITEMS LIST (COEI/BII)

Section I. INTRODUCTION

B-1. SCOPE.

This appendix lists components of the end item and basic issue items for the Modular Causeway Ferry (MCF) to help you inventory the items for safe and efficient operation of the equipment.

B-2. GENERAL.

The Components of End Item (COEI) and Basic Issue Items (BII) Lists are divided into the following sections:

a. Section II. Components of End Item. This listing is for information purposes only, and is not authority to requisition replacements. These items are part of the Modular Causeway Ferry (MCF). As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Items of the COEI are removed and separately packaged for transportation or shipment when necessary. Illustrations are furnished to help you find and identify the items.

b. Section III. Basic Issue Items. These essential items are required to place the Modular Causeway Ferry (MCF) in operation, operate it, and to do emergency repairs. Although shipped separately packaged, BII must be with the MCF during operation and when it is transferred between property accounts. This list is your authority to request/requisition them for replacement based on authorization of the end item by the TOE/MTOE. Illustrations are furnished to help you find and identify the items.

B-3. EXPLANATION OF COLUMNS.

- a. Column (1). Illustration Number (Illus Number). This column gives you the number of the item illustrated.
- b. Column (2). National Stock Number. This column identifies national stock number of the item to be used for requisitioning purposes.
- c. Column (3). Description. CAGEC and Part Number. This column identifies the Federal item name (in all capital letters) followed by a minimum description when needed. The last line below the description is the Commercial and Government Entity Code (CAGEC) (in parentheses) and the part number.
- d. Column (4). Usable On Code. If item needed differs for different models of this equipment, the model is shown in this column.
- e. Column (5). Unit of Issue (U/I). This column indicates how the item is issued for the National Stock Number shown in column two.
- f. Column (6). Quantity Required (Qty Req). This column indicates the quantity required.

Section II. COMPONENT OF END ITEM (COEI)					
(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODE	(5) QTY U/I	(6) REQD
1		ADAPTER, RADIO POWER (OGXD3), 2412	FKY	EA	1
2		ADAPTER,P3 (34712), E28063	FKY	EA	3
3		ANCHOR BOARD ASSY (34712), E20053	FKY	EA	1
4		ANTENNA (23657), 5240	FKY	EA	1
5		ANTENNA (96906), GFE-3	FKY	EA	1
6		CAB, OPERATOR (34712), E02873	FKY	EA	1
7		CHARGER, RADIO BATTERY (OHTU4), HTN9630	FKY	EA	1
8		COMPASS (50967), HB-85	FKY	EA	1
9		CLEAT, MOORING (34712), E07723	FKY	EA	16
10		CONNECTOR, FLEXOR (34712), E02783	FKY	EA	6
11		D-RING, MOORING (34712), E07803	FKY	EA	40
12		FENDER ASSY (34712), E03103	FKY	EA	16
13		HORN, RHINO (34712), E07733	FKY	EA	3
14		INTERCONNECT, MODULE ELECTRICAL (34712), E03003	FKY	EA	1
15		KIT, HYDRAULIC TEST (34712), E28943	FKY	EA	1
16		MANUAL, LUBRICATION ORDER LO55-1945-205-12	FKY	EA	1
17		MANUAL, OPERATOR TM 55-1945-205-10	FKY	EA	1

Section II. COMPONENT OF END ITEM (COEI)					
(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODE	(5) QTY U/I	(6) REQD
18		MANUAL, REPAIR PARTS & SPECIAL TOOLS LIST TM 55-1945-205-24P	FKY	EA	1
19		MANUAL, UNIT DS & GS MAINT TM55-1945-205-24-1, MCF	FKY	EA	1
20		MANUAL, UNIT DS & GS MAINT TM 55-1945-205-24-2, DIESEL ENGINE	FKY	EA	1
21		MANUAL, UNIT DS & GS MAINT TM 55-1945-205-24-3, MARINE GEAR	FKY	EA	1
22		MANUAL, UNIT DS & GS MAINT TM 55-1945-205-24-4, TRANS CASE	FKY	EA	1
23		MAST ASSEMBLY, MAIN (34712), E03123	FKY	EA	1
24		MAST ASSEMBLY, STUB (34712), E18343	FKY	EA	1
25		MODULE, P25B BEACH END (34712), E02853	FKY	EA	3
26		MODULE, PROPULSION, P40P (34712), E28043	FKY	EA	2
27		PLENUM, EXHAUST (34712), E18263	FKY	EA	2
28		PLENUM, INTAKE (34712), E12183	FKY	EA	1
29		PONTOON, P20CR (34712), E02823	FKY	EA	7
30		PONTOON, P20LR (34712), E02833	FKY	EA	7
31		PONTOON, P20RR (34712), E02813	FKY	EA	7

Section II. COMPONENT OF END ITEM (COEI)					
(1) ILLUS NUMBER	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODE	(5) QTY U/I	(6) REQD
32		PONTOON, P40 (34712), E02803	FKY	EA	10
33		RADIO (96906), GFE-1	FKY	EA	1
34		RAILING INSTALLATION (34712), E03136	FKY	EA	1
35		RECEIVER/TRANSMITTER (OHTU4), H5111	FKY	EA	1
36		RECEIVER/TRANSMITTER (OWF67), DSC 500	FKY	EA	1
37		REMOTE AND MICROPHONE (96906), GFE-2	FKY	EA	1
38		SPREADER ASSEMBLY (34712), E19883	FKY	EA	1

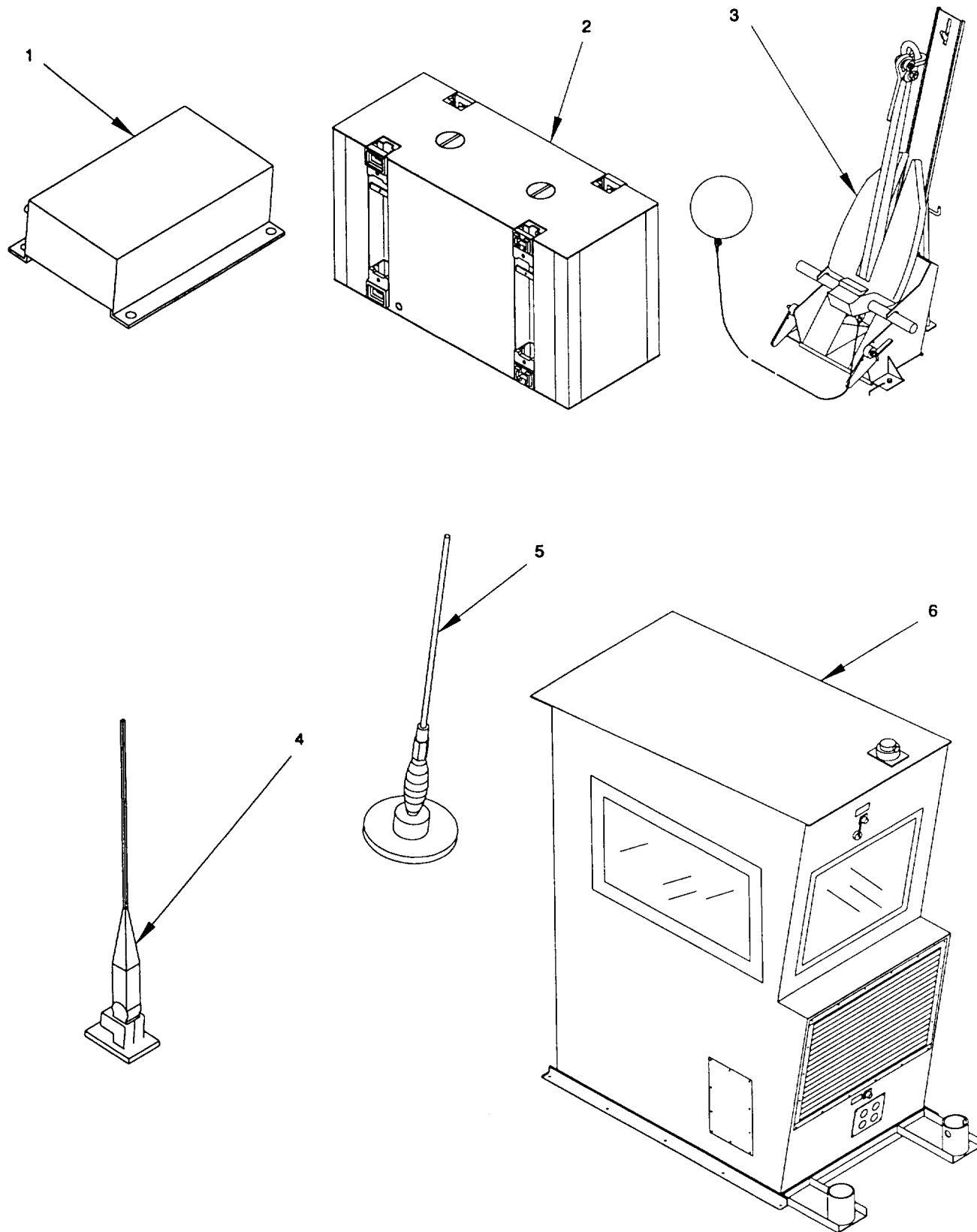


Figure B-1. Components of the End Item (COEI) (Sheet 1 of 5)

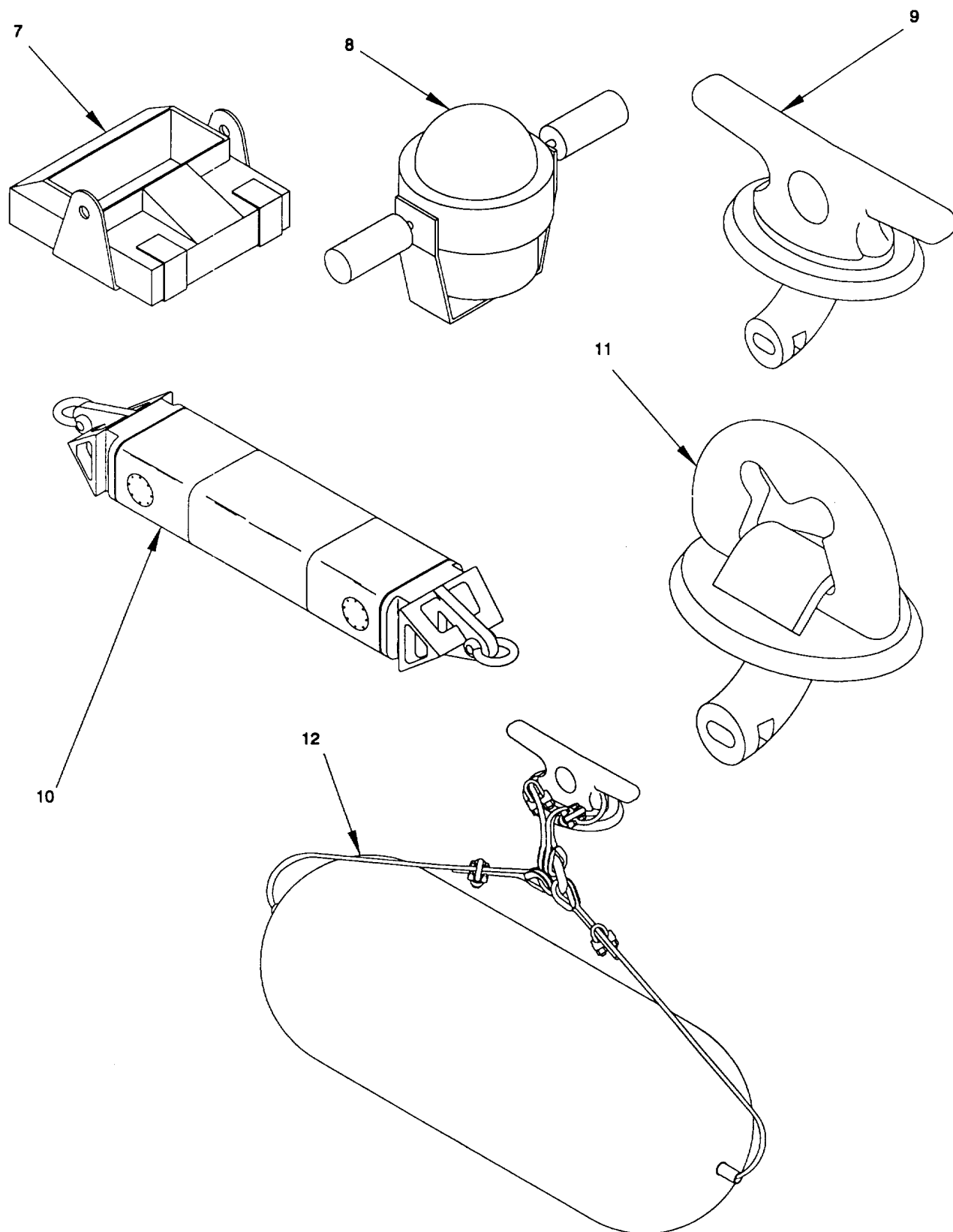


Figure B-1. Components of the End Item (COEI) (Sheet 2 of 5)

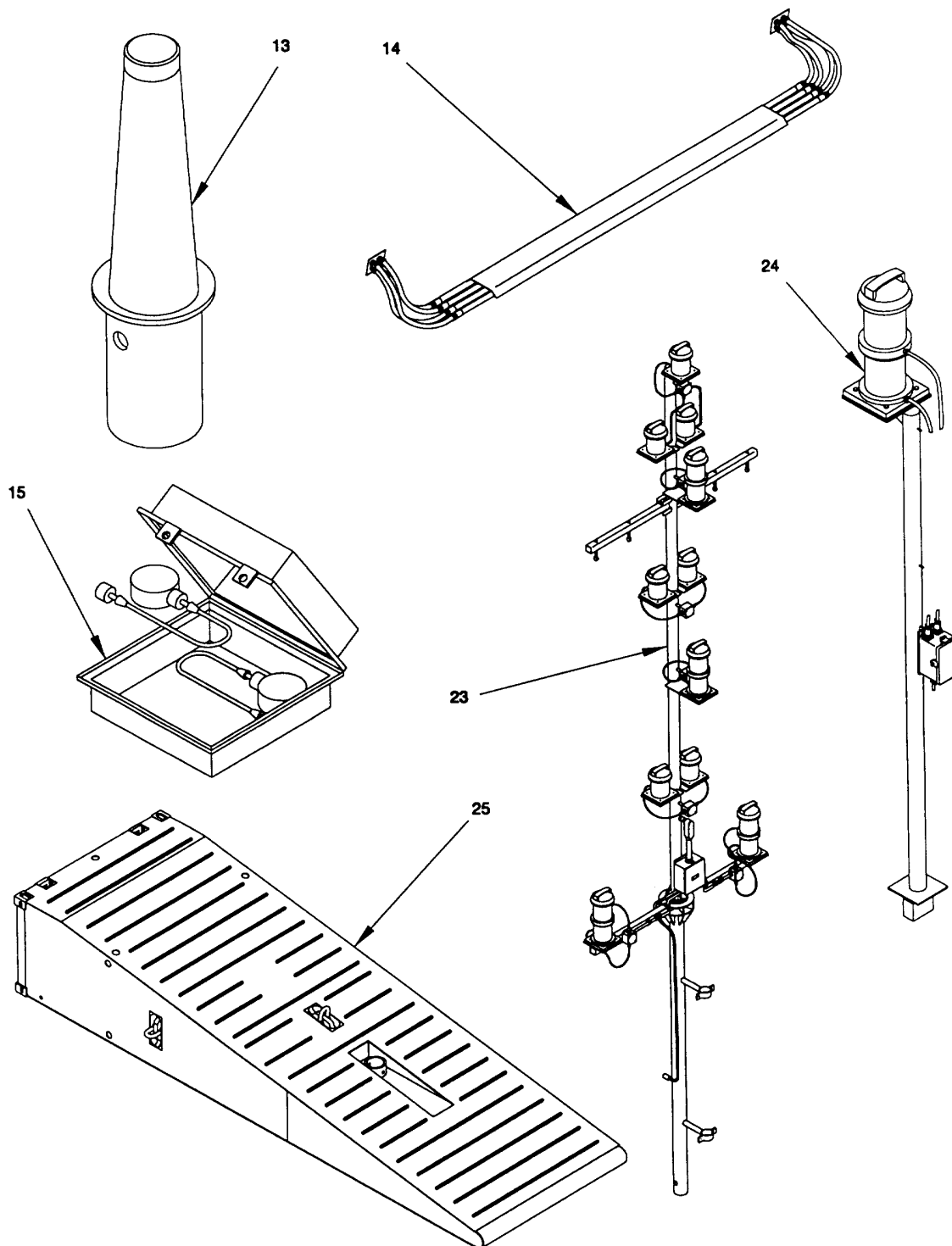


Figure B-1. Components of the End Item (COEI) (Sheet 3 of 5)

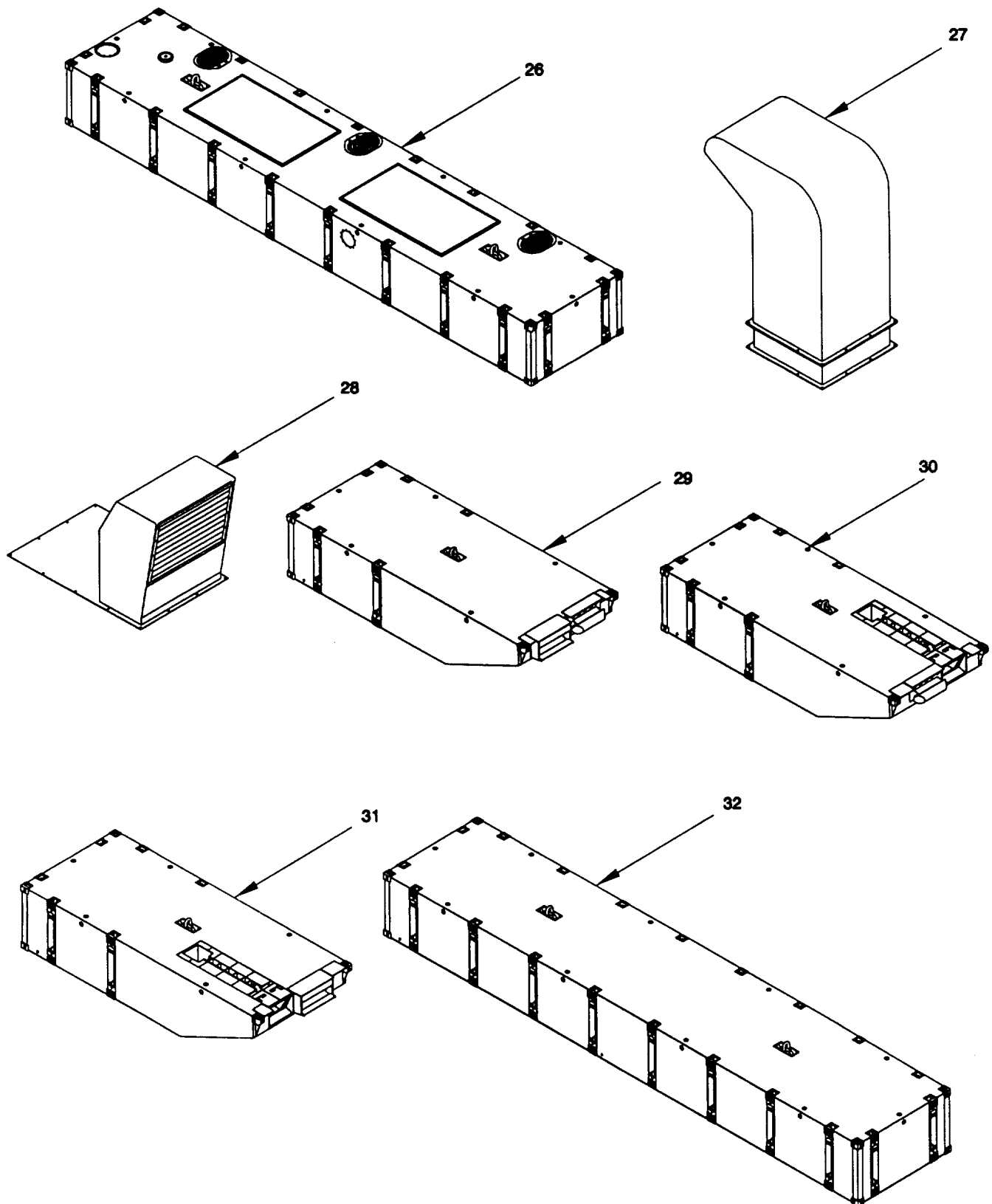


Figure B-1. Components of the End Item (COEI) (Sheet 4 of 5)

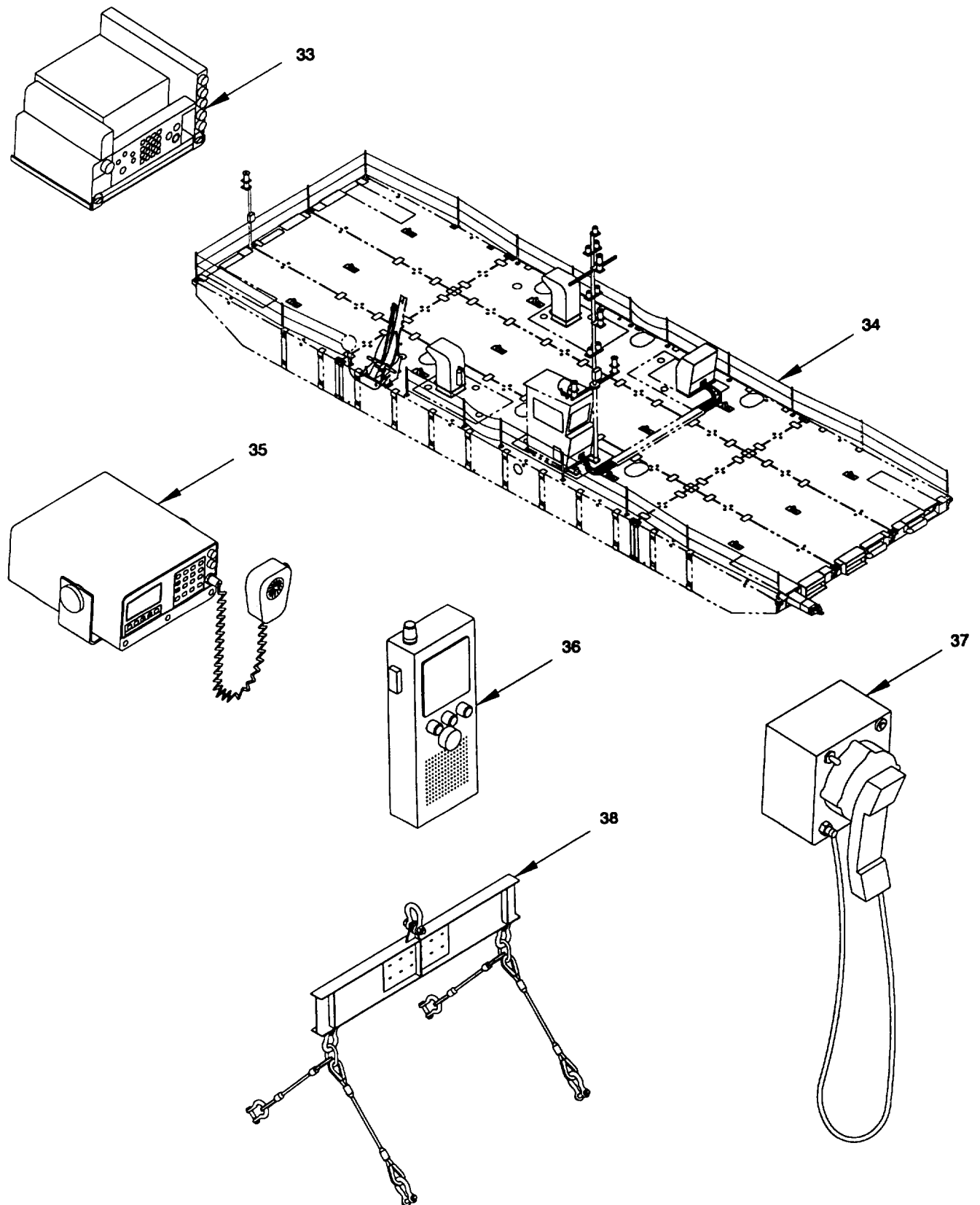


Figure B-1. Components of the End Item (COEI) (Sheet 5 of 5)

Section III. BASIC ISSUE ITEMS LIST (BIIL)

(1) ITEM	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODES	(5) UM	(6) QTY RQD
1	8415-00-082-6108	Apron, Battery Service	FKY	EA	2
2	4210-00-142-4949	Ax, Fire (81348) GGG-A-926	FKY	EA	1
3	5120-00-242-0762	Bar, Wrecking, 36 In. Long (81348) GGG-B-101	FKY	EA	2
4	6135-00-643-1310	Battery, Nonrechargeable, 6V (Battle Lantern) (83740) EV90	FKY	EA	6
5	6135-00-930-0030	Battery, Flashlight, Size "D", Alkaline (80058) BA3030	FKY	BX	1
6	Local Purchase Item- Water-Jel AWK Fire Blanket, H&H Associates Inc., P.O. Box 4496, Alexandria, VA 22303, Phone 1- 800-326-5708	Blanket, Fire, 72" X 60"	FKY	EA	1
7	5340-00-275-4583	Clips, Halyard	FKY	BOX	2
8	Local Purchase Item- Lifesaving Systems Corp., 720 4th St. SW, Ruskin, FL 33570-1829, Phone 813-645-2768	Coverall, Antiexposure, Sterns Model 1FS-580, Orange (1 per crew member)	FKY	EA	6
9	5120-00-224-1390	Crowbar, Wedge Point, 60 In. Long	FKY	EA	2
10	Local Purchase Item- Water-Jel AWK Kit, H&H Associates, Inc. P.O. Box 4469, Alexandria, VA 22303 Phone 1-800-326-5708	Dressing, Burn, Kit (contains 2/8" X 18", 1/4" X 16", 4/4" X 4", 1/12" X 16" [Face Mask] dressings, and 1 package of Burn-Jel topical dressing	FKY	EA	1
11	4210-00-203-0217	Extinguisher, Fire, Portable, 15 lbs. CO ₂ capacity (33525) 466182	FKY	EA	3
12	4220-00-542-2048	Faceshield, Safety (1 per crew member)	FKY	EA	6

Section III. BASIC ISSUE ITEMS LIST (BIIL)

(1) ITEM	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODES	(5) UM	(6) QTY RQD
13		Fast Lube Oil Change System (FLOCS), Pump and Hoses	FKY	EA	1
14	5120-00-223-8921	Fld, 12 inch Wood	FKY	EA	2
15	8345-00-935-0445	Flag, Signal, "A" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
16	8345-00-926-6803	Flag, Signal, "B" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
17	8345-00-935-0451	Flag, Signal, "O" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
18	8345-00-926-6814	Flag, Signal, "U" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
19	8345-00-935-0455	Flag, Signal, "V" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
20	8345-00-935-0456	Flag, Signal, "W" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
21	8345-00-935-0457	Flag, Signal, "Y" Intn'l Code, Size 6 (81349) MIL-F-2692	FKY	EA	1
22	6230-00-264-8261	Flashlight, Watertight (81349) MIL-F-3747	FKY	EA	2
23	8415-00-266-8677	Gloves, Chemical Battery Service	FKY	PR	2
24	8415-01-267-9661	Gloves, Anti-Flash (1 pair per crew member) (81349) MIL-G-2874	FKY	PR	6
25	8415-00-634-4658	Gloves, Leather Palm (1 pair per crew member) (58536) A-A-50021	FKY	PR	5
26	8415-00-266-8691	Gloves, Electric (1 pair per crew member) (81348) ZZ-G-401	FKY	PR	6
27	4240-00-052-3776	Goggle, Clear Lens, Chipping (1 per crew member)	FKY	EA	6

Section III. BASIC ISSUE ITEMS LIST (BIL)

(1) ITEM	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODES	(5) UM	(6) QTY RQD
28	4240-00-190-6432	Goggle, Industrial, No Vents (Chemical Splash)(1 per engineer) (58536) A-A-110	FKY	EA	2
29	8465-01-004-2893	Goggle, Safety, Wind, Dust, Sand, Spray (1 per crew member) (81349) MIL-G-43914	FKY	EA	6
30	5120-00-243-2957	Hammer, Sledge, 10 lb	FKY	EA	2
31	8415-00-279-2205	Hard hat, Blue (58346) A-A-2269 Type 2 Class A Style A	FKY	EA	2
32	8415-00-823-7575	Hard hat, Brown (58346) A-A-2269 Type 2 Class A Style A	FKY	EA	4
33	4240-00-022-2522	Harness, Safety, Torso (80204) ANSI Z359.1	FKY	EA	6
34	2040-00-268-9250	Hook, Boat, 10 ft Handle (21530) H389	FKY	EA	2
35	Local Purchase Item Kit, GEN367C	Lockout Tagout, Pig	FKY	EA	1
36	4730-00-542-3359	Kit, Pipe Repair, Emergency (81349) MIL-4-17882B	FKY	EA	1
37	6230-00-783-6519	Lantern, Battle, SYM 100.2, with red filter, Body Assembly (62025A),M1 6377/53-001	FKY	EA	1
38	6230-00-783-6519	Lantern, Battle, SYM 100.2, no filter, Body Assembly (62025A),M1 6377/53	FKY	EA	2
39	6230-00-776-5920	Lantern, Battle, SYM100.2, Handle and Switch	FKY	EA	3
40	4240-00-022-2518	Lanyard, Safety Harness (80204) ANSI Z359.1	FKY	EA	6
41	6260-01-086-8077	Light, Distress, Personnel Marker (83239) 2172-A-1	FKY	EA	24
42	4020-00-240-2161	Line, Halyard, Nylon, 1/4 inch x 300 ft	FKY	EA	1

Section III. BASIC ISSUE ITEMS LIST (BIIL)

(1) ITEM	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODES	(5) UM	(6) QTY RQD
43	4020-01-344-0552	Line, Heaving, Safety, 100 ft (OGU87) NIS-G-0213	FKY	EA	2
44	4020-00-530-0698	Line, Retrieving, Ring Bouy (81349) MIL-R-24049	FKY	RL	1
45	5120-00-255-1476	Maul, Ship's, 5 lb. (Damage Control Plugs) (58536) A-A-1285	FKY	EA	1
46	5510-00-260-8949	Pneumatic Test Set-Up	FKY	EA	1
47		Plug, Soft Wood, 10" X 7" X 12" Long (80064) S8800-461043	FKY	EA	5
48	5510-00-260-8973	Plug, Soft Wood, 8" X 4" X 10" Long (80064) S88000-461043	FKY	EA	5
49	5510-00-260-8969	Plug, Soft Wood, 7" X 3" X 10" Long (80064) 803-461043	FKY	EA	5
50	5510-00-260-8953	Plug, Soft Wood, 1" X 0" X 3" Long (80064) 803-461043	FKY	EA	5
51	5510-00-260-8958	Plug, Soft Wood, 2" X 0" X 4" Long (80064) S8800-461043	FKY	EA	5
52	5510-00-260-8962	Plug, Soft Wood, 3" X 0" X 8" Long (80064) 803-461043	FKY	EA	5
53	4220-00-200-0538	Preserver, Life, Inherently Buoyant, Vest Type w/Collar (1 per crew member) (81349) MIL-L-18045	FKY	EA	8
54	4220-00-276-8926	Preserver, Life, Vest (1 per crew member) (81349) MIL-L-7653	FKY	EA	8
55	4240-00-022-2946	Protector, Aural, Sound (1 per crew member) (71483) E31C	FKY	EA	6
56		Pump, AOAP Sampling	FKY	EA	1

Section III. BASIC ISSUE ITEMS LIST (BIL)

(1) ITEM	(2) NATIONAL STOCK NUMBER	(3) DESCRIPTION, CAGE AND PART NUMBER	(4) USABLE ON CODES	(5) UM	(6) QTY RQD
57	8345-01-101-1101	Shape, Day Maritime, Diamond, Black, 2 ft. dia., 4 ft. Long (81349) MIL-S-29134	FKY	EA	1
58	8345-00-174-0453	Shape, Day Maritime, Ball, Black, 2 ft. dia., 4 ft. Long (81349) MIL-S-29108	FKY	EA	2
59	2090-00-058-3737	Shoring, Steel, Adjustable, Short, 3 ft. to 5 ft. (81349) MIL-S-23965	FKY	EA	4
60	1370-01-030-8330	Signal, Distress, Orange Smoke, Red Illumination (10001) DL3139734	FKY	EA	12
61	9390-01-078-8660	Tape, Retroreflective, 3" X 50 yds, Adhesive Backed (94960) 3150-3X50YD	FKY	RL	1
62	5180-00-629-9783	Tool Kit, Marine and Rail	FKY	EA	1
63	5510-00-268-3479	Wedge, Plug, Tapered, Hardwood, 2" X 2" X 8" Long (80064) S8800-461043	FKY	EA	5
64	5510-00-268-3475	Wedge, Shoring, Tapered, Hardwood, 1 1/2" X 2" X 12" Long (80064) S8800-461043	FKY	EA	5
65	8465-00-254-8803	Whistle, Plastic Ball w/Lanyard 58536) A-A-55106	FKY	EA	24

APPENDIX C

EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

C-1 SCOPE.

Section II lists Expendable/Durable Supplies and Materials (EDSM) you will need to operate and maintain the Modular Causeway Ferry (MCF). These items are authorized to you by CTA 50-970, Expendable/Durable Items (Except Medical, Class V, Repair Parts, and Heraldic Items).

C-2 EXPLANATION OF COLUMNS.

a. Column 1 - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e.g., "Cleaning solvent P-D-680 (Appendix C, item 2)").

b. Column 2 - Level. This column identifies the lowest level of maintenance that requires the listed item. The symbol designations are as follows:

- C Operator or crew
- O Unit Level maintenance
- F Direct Support
- H General Support

c. Column 3 - National Stock Number. This column indicates the National stock number assigned to the item. Use it to request or requisition the item.

d. Column 4 - Description CAGE and Ref Number. This column indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Commercial and Government Entity (CAGE) code in parentheses followed by the part number.

e. Column 5 - Unit of Measure (U/M). This column indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e.g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST				
(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
1	O	8030-01-126-9460	Adhesive (05972) #222, MIL-S-46163A, Type II, Grade M	EA
2	O	8040-01-250-3969	Adhesive (05972) #242, MIL-S-46163A, Type II, Grade N	EA
3	O	8040-00-092-2816	Adhesive, Epoxy (12405) EPS-608	EA
4	O	8040-01-194-0391	Adhesive, Silicone (71984) RTV-732	EA
5	O	6850-00-181-7929 6850-00-181-7933	Antifreeze, Ethylene Glycol, (81349) ASTM-D4985 1 gallon container 5 gallon container	GL GL
6	O	7920-01-088-5188	Brush, Soft Bristle (53800) 30G14493	EA
7	O	7920-00-044-9281	Cloth, Cleaning (81349) MIL-C-85043	LB
8	O	7920-00-292-9204	Cloth, Cleaning, extra heavy (80244) A-A-162, Type 1, Class 2	MX
9	C	8030-00-209-8005	Compound, Antiseize (81348) TT-S-1732 (M22361)	OZ
10	C,O	6850-00-926-2275	Compound, Cleaning, windshield washer, 1 pint (81348) O-C-1 901	PT
11	C		Compound, Rust Preventative (81349), MIL-C-16173, Grade 2	
12	O		Compound, Sealing (05972) 598	EA
13	O	8030-01-009-2590	Compound, Sealing (08854) 42029	CN
14	C		Compound, Silicone (81349), MIL-C-21567 or commercial equivalent	EA
15	O	5970-00-241-5406	Compound, Thermal Joint (05820) 120-8	OZ
16	O	7930-00-282-9699	Detergent, General Purpose, 1 gallon (80244) MIL-D-16791 Type I	GL

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST				
(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
17	O	6810-00-236-0702	Electrolyte, Acid, Sulfuric (81348) O-S-801 Class III 1 gallon	GL
18	O	6810-00-904-9372 9150-00-993-6621	5 gallons Fluid, Hydraulic, Mobil DTE 25	GL GL
19	C	9150-00-145-0268	(19135) 60263-1 Grease, Aircraft	CN
20	O	9150-00-985-7246	(81349) MIL-G-81322 Grease, Aircraft and Instrument	LB
21	F		(81349) MIL-G-23827 Grease, lithium	TU
22	C, O	9150-00-929-7946	(73219) GR-132 Grease, Lubriplate	TU
23	O		(73219) 1200-2 Grease, Mobilux Grade No 2 or equivalent E.P. Grease, NLGI grade 2	TU
24	F	9150-01-080-9652	(19135) 64127-4 Grease, Silicone (81349) MIL-L-1 5719	EA
25	O	9150-00-530-6814	Grease, Wire Rope, (81349) MIL-G-18458	CN
26	C	6850-00-003-5295	Lubricant, Compound, Cleaning (81349) MIL-C-83360	CN
27	C		Oil, Light Lubricating, General Purpose (81348) W-L-820	PT
28	C, O	9150-01-035-5393	Oil, Lubricating, Gear	CN
29	O		Oil, Mobilgear 626 (19135) 61085-7	QT
30	O		Oil, Mobilgear 629 (19135) 61086-5	QT
31	O	9150-00-261-7899	Oil, Penetrating (81348) W-P-216	EA
32	O		Oil, SAE Grade 30, Mobil Delvac 1230 (if operating below 0° F.) (19135) 44067-7	PT

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST				
(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
33	O	9150-01-219-3276	Oil, SAE Grade 50, Mobil Delvac 1250 (if operating above 0° F.)	PT
34	O		(19135) 44097-4 Oil, SAE 40, API Class CD-II,, Sulfated Ash less than 1.0%, Mobil Delvac 1340, MIL-L-2104D	QT
35	C		(19135) 44073-5 Paint, Amercoat 385 PA Oxide Red Primer (09869) 373-930	GL
36	C		Paint, Amercoat 385 #27 Haze Grey (09869) 353-070	GL
37	C		Paint, Amercoat 385 AS Mid Graphite Grey (09869) 372-130	GL
38	C		Paint, Amercoat 385 Black (09869) 994-086	GL
39	C		Paint, Enamel, Yellow	GL
40	C		(17833) TTE-490 Paint, Primer, Red Oxide	GL
41	C, O	8030-00-204-9149	(17833) TTP-664, #13538 Sealant, Pipe Thread, 50 ML Tube,	EA
42	O		(05972) #592 Sealant, RTV Silicone, Tube	EA
43	O	8030-00-339-0310	(4M493) #6BC Sealant, Thread, 50 ml bottle	EA
44	O		(05972) 56931 Sleeve, Solder (63590) LSSS-300	EA
45	O	6505-00-055-9422	Soda, Baking (Sodium Bicarbonate) (60060) NDC00074-4103-03	OZ
46	O	6850-00-664-5685 6850-00-264-9038 6850-00-274-5421 6850-00-285-8011	Solvent, dry cleaning P-D-680 Type II (58536) A-A-71 1 quart container 1 gallon can 5 gallon drum 55 gallon drum	QT GL GL GL

Section II. EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST				
(1) ITEM NUMBER	(2) LEVEL	(3) NATIONAL STOCK NUMBER	(4) DESCRIPTION	(5) U/M
47	O	8030-00-889-3535	Tape, Teflon, 1/2 In	RL
48	C		(81348) MIL-T-27730 Thinner, Paint, Amercoat #65 or equivalent	GL
49	O	5970-01-124-7344	09869 100-120 Tubing, Heat Shrink (06090) MIL-LT-1/4	FT
50		5970-01-124-8565	Tubing, Heat Shrink (06090) MIL-LT-3/8	FT
51	O		Tubing, Heat Shrink (06090) MIL-LT-1/2	FT
52	O	5970-01-101-7407	Tubing, Heat Shrink (75037) EPS-200 1-1/2	FT
53	O		Tubing, Heat Shrink (75037) EPS-200 2	FT
54	C	6810-00-297-9540	Water, Distilled, 5 gallons (96906) MS36300-5	GL
55	O	9330-01-250-2958	Wrap, Spiral (06383) T50N	EA
56		9330-01-311-3859	Wrap, Spiral (06383) T25N	EA
57		E24628-3	Wrap, Tie, Nylon, .140 X 11.10 (56501) TY526MX	Bdl
58	H	8010-01-349-8055 8010-01-380-3306	Zinc, Inorganic, No. 531 0N4K0 (IC531) 4 Gallon Package 1 Gallon Package	GL

C-5/(C-6 blank)

APPENDIX D

MANUFACTURED ITEMS LIST (MIL)

There are no parts authorized for manufacture.

INDEX

Title	Page, Figure, Table
A	
Alignment, Installation, Marine Transmission	L-2
Alignment, Marine Transmission	M-1
All Other Parts, Cleaning	J-1
Assembly, Marine Transmission	K-1
Assembly, Forward Clutch, Marine Transmission	K-1
Assembly, Output, Marine Transmission	K-2
Assembly, Main Housing, Marine Transmission	K-4
Assembly, Internal Parts, Marine Transmission	K-4
Adjustment, Tapered Bearing, Marine Transmission	K-4
Assembly, Final, Marine Transmission	K-4
Assembly, Selector with Trolling Valve Option, Marine Transmission	K-4
Assembly, Control Valve, Hydraulic	D-1
Neutral	D-1
Forward Clutch Applied	D-2
Reverse Clutch Applied	D-2
Assembly Drawings, Marine Transmission	O-1
Housing Assembly - Exploded View	(f) O-1
Selector Valve Assembly - Exploded View	(f) O-2
Forward Clutch - Exploded View	(f) O-3
Reverse Clutch - Exploded View	(f) O-4
Output Shaft Assembly -SC - Exploded View	(f) O-5
Output Shaft Assembly -DC - Exploded View	(f) O-6
Trolling Valve Assembly 23505391 - Exploded View	(f) O-7
Assembly, Oil Pump	B-3
Pump, Oil	B-3
Tube, Suction	B-3
Assembly, Selector Valve	B-3
Valve, Main Regulator, Parts Group	B-3
Valve, Selector Valve, Parts Group	B-3
B	
Back Driving	C-3
Bushings and Sleeves, Inspection	J-2
C	
Capscrew Locks, Cleaning and Inspection	J-1
Castings, Inspection	J-2
Chart, General Information, Description	B-4
Chart, Troubleshooting	F-1
Circuit, External Oil	D-1
Cleaning and Inspection	J-1
Component Parts, Preventive Maintenance	E-2
Cleaning	E-2
Cleaning Interval	E-2
Filter Screen	E-2

INDEX - Continued

Title	Page, Figure, Table
Component Parts, Preventive Maintenance (Continued)	
Heat Exchanger and Hoses	E-2
Installation	E-2
Oil Filter Assembly	E-2
Removal	E-2
Connecting Linkage, Installation, Marine Transmission	L-3
Conversion for Use with Left Hand Engine	C-3
D	
Description, Marine Transmission	B-1
Disassembly, Marine Transmission	I-1
Forward and Reverse Clutch	I-2
Miscellaneous External Parts	I-1
Output Group, Removal	I-7
Selector Valve, Disassembly	I-8
Distribution	A-2
Drive, Direction of	C-1
Drive Spider, Inspection	J-2
Driving Ring, Inspection	J-2
E	
Engine and Marine Transmission Alignment to Propeller Shaft, Marine Transmission	M-1
F	
Flexible Hose, Inspection	J-2
G	
Gaskets, Cleaning and Inspection	J-1
Gear Teeth, Inspection	J-2
General Information	A-1
H	
Heat Exchanger	B-4
Hydraulic System	D-1
Description	D-1
Hydraulic System, Installation, Marine Transmission	L-3
Hydraulic System, Preventive Maintenance	E-1
Draining	E-1
Gravity	E-1
Suction	E-1
Filling	E-2
Oil Capacity and Weight	E-1
Oil Change Interval	E-1
Oil Level	E-1
Output Seal Lubrication - Ratios 3.28 -4.95:1	E-1

INDEX - Continued

Title	Page, Figure, Table
Installation, Marine Transmission	L-1
Installation, Prior to	L-1
Checking Marine Transmission Flange	L-1
Checking Marine Transmission Pilot Ring	L-1
Checking Face of Engine Flywheel Housing	L-1
Checking Bore of Engine Flywheel Housing	L-1
Checking Driving Ring Surface of Engine Flywheel	L-2
Checking Driving Ring Pilot Bore of Engine Flywheel	L-2
M	
Mounting Brackets, Inspection	J-3
O	
O-rings, Cleaning and Inspection	J-1
Oil Pump Assembly, Cleaning	J-1
Oil Seals, Cleaning and Inspection	J-1
Oil Seal Replacement	G-1
Oil Seal Replacement, After	G-1
Drive Line Connection	G-1
Filling	G-2
Oil Seal Replacement, Prior to	G-1
Draining	G-1
Output Flange Clearance	G-1
Oil Seal Replacement, Ratios 1.12 - 3.10:1	G-1
Installation	G-1
Removal	G-1
Oil Seal Replacement, Ratios 3.28 - 4.95:1	G-1
Installation	G-2
Removal	G-2
Oil Tubes, Inspection	J-2
Operation, Principles of	C-1
Description	C-1
General	C-1
Option, Hydraulic	D-2
Valve, Trolling	D-2
Forward or Reverse	D-2
Non-trolling Mode	D-2
Optional Equipment Offered by DDC	B-1
Ordering parts	A-2
Source, Ordering Parts	A-2
Method, Ordering Parts	A-2
Orifices and Passages, Inspection	J-3
Output Flange Connection, Installation, Marine Transmission	L-3

INDEX - Continued

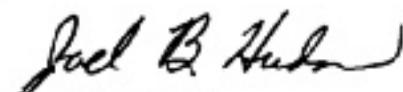
Title	Page, Figure, Table
P	
Parts, Forward and Reverse Clutch Group	B-2
Housing Gear, Clutch	B-2
Pack, Clutch	B-2
Shaft, Clutch	B-2
Parts, Input Group	B-1
Blocks, Rubber	B-2
Gear, Input	B-2
Ring, Driving	B-2
Shaft, Gear, Input	B-2
Spider, Drive	B-2
Torsion Coupling	B-1
Parts, Main Housing Group	B-3
Assembly, Main Housing	B-3
Assembly, Manifold	B-3
Carrier, Bearing	B-3
Parts, Output Group	B-4
Flange, Output	B-4
Gear, Output	B-4
Shaft, Output	B-4
Parts Shipment	A-2
Method, Ordering Parts	A-2
Destination, Ordering Parts	A-2
Piston Rings, Cleaning and Inspection	J-1
Power Flow	C-1
Neutral	C-1
Forward	C-1
Reverse	C-1
Pressure and Temperature Checks	F-1
Main Pressure	F-1
Cooling and Lubrication	F-1
Temperature	F-1
Pressure and Temperature Gauge Assemblies, Inspection	J-2
Preventive Maintenance	E-1
Lubrication	E-1
Overhaul Interval	E-1
Previously Sealed Joints, Cleaning	J-1
Propeller Shaft Installation, Alignment, Marine Transmission	M-1
R	
Reduction Ratios	B-1
Removal, Engine	H-1
Removal, Engine Bedrail Connections	H-1

INDEX - Continued

Title	Page, Figure, Table
Removal, Marine Transmission	H-1
Prior to	H-1
Connecting Linkage	H-1
Hydraulic System	H-1
Support	H-1
Lifting Bolt Holes Provided on DDC Products	H-1
Removal, Output Flange	H-1
Roller Bearings, Cleaning	J-1
Roller Bearings, Inspection	J-1
Rubber Blocks, Inspection	J-2
S	
Seal Ring, Cleaning and Inspection	J-1
Seal Washer, Cleaning and Inspection	J-1
Snap Rings, Inspection	J-2
Splined Parts, Inspection	J-2
T	
Threaded Parts, Inspection	J-2
Thrust Washers and Spacers, Inspection	J-2
Torque Values, Marine Transmission	N-1
Torsional Coupling, Inspection	J-2
Troubleshooting	F-1
V	
Valve Seats, Inspection	J-2
Visual Inspection, Periodic, Preventive Maintenance	E-2
Assemblies, Pressure and Temperature Gauges	E-2
Connecting Lines, Heat Exchanger and Oil Filter	E-2
General	E-2

By Order of the Secretary of the Army:

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RECOMMENDATION MAKE A CARBON COPY OF THIS
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The Metric System and Equivalents

Linear Measure

1 centimeter = 10 millimeters = .39 inch
 1 decimeter = 10 centimeters = 3.94 inches
 1 meter = 10 decimeters = 39.37 inches
 1 dekameter = 10 meters = 32.8 feet
 1 hectometer = 10 dekameters = 328.08 feet
 1 kilometer = 10 hectometers = 3,280.8 feet

Weights

1 centigram = 10 milligrams = .15 grain
 1 decigram = 10 centigrams = 1.54 grains
 1 gram = 10 decigrams = .035 ounce
 1 decagram = 10 grams = .35 ounce
 1 hectogram = 10 decagrams = 3.52 ounces
 1 kilogram = 10 hectograms = 2.2 pounds
 1 quintal = 100 kilograms = 220.46 pounds
 1 metric ton = 10 quintals = 1.1 short tons

Liquid Measure

1 centiliter = 10 milliliters = .34 fl. ounce
 1 deciliter = 10 centiliters = 3.38 fl. ounces
 1 liter = 10 deciliters = 33.81 fl. ounces
 1 dekaliter = 10 liters = 2.64 gallons
 1 hectoliter = 10 dekaliters = 26.42 gallons
 1 kiloliter = 10 hectoliters = 264.18 gallons

Square Measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. inch
 1 sq. decimeter = 100 sq. centimeters = 15.5 sq. inches
 1 sq. meter (centare) = 100 sq. decimeters = 10.76 sq. feet
 1 sq. dekameter (are) = 100 sq. meters = 1,076.4 sq. feet
 1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
 1 sq. kilometer = 100 sq. hectometers = .386 sq. mile

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
 1 cu. decimeter = 1000 cu. centimeters = 61.02 cu. inches
 1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Approximate Conversion Factors

<i>To change</i>	<i>To</i>	<i>Multiply by</i>	<i>To change</i>	<i>To</i>	<i>Multiply by</i>
inches	centimeters	2.540	ounce-inches	Newton-meters	.007062
feet	meters	.305	centimeters	inches	.394
yards	meters	.914	meters	feet	3.280
miles	kilometers	1.609	meters	yards	1.094
square inches	square centimeters	6.451	kilometers	miles	.621
square feet	square meters	.093	square centimeters	square inches	.155
square yards	square meters	.836	square meters	square feet	10.764
square miles	square kilometers	2.590	square meters	square yards	1.196
acres	square hectometers	.405	square kilometers	square miles	.386
cubic feet	cubic meters	.028	square hectometers	acres	2.471
cubic yards	cubic meters	.765	cubic meters	cubic feet	35.315
fluid ounces	milliliters	29.573	cubic meters	cubic yards	1.308
pints	liters	.473	milliliters	fluid ounces	.034
quarts	liters	.946	liters	pints	2.113
gallons	liters	3.785	liters	quarts	1.057
ounces	grams	28.349	liters	gallons	.264
pounds	kilograms	.454	grams	ounces	.035
short tons	metric tons	.907	kilograms	pounds	2.205
pound-feet	Newton-meters	1.356	metric tons	short tons	1.102
pound-inches	Newton-meters	.11296			

Temperature (Exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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